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REAUTHORIZATION OF COMMERCE DEPARTMENT TECHNOLOGY PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

SECOND SESSION

ON

THE REAUTHORIZATION OF THE COMMERCE DEPARTMENT'S TECHNOLOGY PROGRAMS

MAY 20, 1988

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REAUTHORIZATION OF COMMERCE DEPARTMENT TECHNOLOGY PROGRAMS

FRIDAY, MAY 20, 1988

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:30 a.m., in Room SR-253, Russell Senate Office Building, Hon. John D. Rockefeller, IV presiding.

Staff members assigned to this hearing: Pat Windham, professional staff member and Mark Farrell, minority professional staff member.

OPENING STATEMENT BY SENATOR ROCKEFELLER

Senator ROCKEFELLER. Good morning, everyone. We very much welcome your presence at this hearing at which, among other things, we will be discussing the reauthorization of the Commerce Department's technology programs.

I want to start by restating a fundamental truth that cannot be repeated often enough. In today's world, science and technology is this country's great competitive strength. Moreover, it is not a strength that we can any longer take for granted. Two recent events show that we cannot afford to remain complacent about America technology. One event of overwhelming importance is the continued trade deficit, and I recognize that the March deficit came in at less than $10 billion, and that is terrific. But a trade deficit, unlike a budget deficit, is something that you have to get all the way down to zero and then up at least one dollar before you have done anything which is more than negative. A budget deficit presumably you can hold at $25 billion or $50 billion without hurting the nation.

So, although moving in the right direction, it is a very high, an unacceptably high trade deficit.

We keep mortgaging our future, and that cannot be allowed. We have to restore the nation's competitiveness in manufacturing.

A second event illustrates the type of challenge that we face in specific industries. Japan's Ministry of International Trade and Industry has just announced a ten year, $112 million next generation technology project in superconducting materials and devices. Its purpose is to develop the technologies needed for the creation of a superconducting computer, including the technology for mass production.

No one in this country obviously wants to simply imitate what the Japanese might be doing. Our systems are entirely different. In the United States we rely on industry to take the lead on new technologies. Nevertheless, the challenge that we face is enormouse and government agencies can play a vital supporting role by funding scientific research and by providing the technical service needed both to create and to use new technologies.

The technology programs of the Department of Commerce, in my judgment, are among the most important of these Federal efforts. The National Bureau of Standards provides basic measurement services and helps industry develop the techniques necessary to improve manufacturing and speed the commercialization of new discoveries. I think that the National Bureau of Standards is one of the most important agencies in all of the Federal Government.

The Office of Productivity, Technology and Innovation help Congress write the laws which now allow new forms of research cooperation, including multicompany research ventures and new collaborations between companies and Federal laboratories. Under a provision that I was lucky enough to author with Congressman Boehlert in the new trade bill, the National Bureau of Standards will begin new technology extension activities which will share the Bureau's expertise, which is what they want to do with the states, and strengthen state services to a wide range of American companies hardpressed by foreign competition.

And finally, both the National Technical Information Service and the new Japanese technical literature program collect and disseminate important technical information. During this morning's hearing we will hear from the Commerce Department witnesses and review the budget requests and progress of these Commerce Department efforts. We will also try to put the department's efforts into perspective by hearing from a distinguished panel knowledgeable about general issues of technology and competitiveness.

We will hear a summary of an important new report on competitiveness by the National Academy of Engineering. The report is an excellent review of the general issues facing both industry and government, and it raises important questions about the role of the Federal Government in supporting industrial technology.

Next, we will turn to an in-depth analysis of one critical new technology, advanced materials. Some analysts predict that advanced ceramics and composites and related materials will soon be a multi, multibillion dollar global industry.

Will the United States take the lead in this huge new market, or will our Japanese friends win this one, too?

At the request of the Commerce Committee, the Congressional Office of Technology Assessment has studied both opportunities and obstacles in advanced materials. I have actively followed the progress of that report, and I am particularly pleased that OTA will release that major report this morning.

Last, but obviously not least, we will examine the important issue of disseminating technical information to the researchers who need it, a role which largely falls to the National Technical Information Service. For myself, I am very pleased that we will hear from Dr. Harold Shill the distinguished head of West Virginia University's Research Library and the legislative chairman of the American Libraries Association.

Hal, for those of you who do not know him, is a wealth of information on technical information, and we are extremely fortunate to have him in West Virginia as well as here this morning. He will help us understand the role that NTIS currently plays in distributing technical information.

I have an opening statement that Senator Hollings would like to have included in the record.

[The statements follows:]

OPENING STATEMENT BY THE CHAIRMAN

Last year "competitiveness" was all the rage. This year we hear the word less. Perhaps some think the issue is passe, or the urgency gone. But I can assure you that the urgency was real last year and remains real today. We see no shortage of new challenges to our nation's industrial position and technological leadership. From automobile parts to semiconductors to the newest superconductors, American industry faces strong competition. We remain the world's leader in science and invention, but continue to lag all too often in manufacturing and the commercialization of new ideas. We have lost one industry after another. In an era when technology is America's one great competitive strength, it's time for us as a nation to find better ways to create and use advanced technology.

The federal government can and must help, but expensive new federal programs are not the way to go. Even if we had great amounts of money, which we do not, the federal government cannot spend its way to national prosperity. Industry must take responsibility for its own future. But in a world of government-to-government competition, it is naive and dangerous to say government has no role in aiding industry. Government needs to support the fundamentals -- education, support for science and engineering, a good economic climate, and an active and fair trade policy. The burden on government is to develop programs which are truly useful, truly cost-effective, and then carried out not in splendid isolation from companies and the states but rather in partnership with them.

The technology programs of the Commerce Department, particularly the National Bureau of Standards, meet that test. For decades the Bureau has provided American industry with technical services essential to high-quality, cost-effective manufacturing. When the Commerce Committee's provisions in the trade bill finally become law, the Bureau's mission will be upgraded to take on new challenges. It will support new research to speed the commercialization and production of superconductors and other emerging technologies, and it will provide information and assistance to hard-pressed small American manufacturing companies. In building upon proven existing programs, we are building upon strength.

Our hearing this morning will help the Committee as it continues to explore ways to give industry the technical support it needs to stay strong in world competition. I look forward to reviewing the testimony of our witnesses.

Senator ROCKEFELLER. Now, our first witness is our senior witness, Deputy Secretary of Commerce Donna Tuttle who I, from various seats around this platform here, have praised so much and so often that I will just simply welcome you, Secretary Tuttle, and welcome your testimony.

STATEMENT OF DONNA F. TUTTLE, DEPUTY SECRETARY OF COMMERCE, DEPARTMENT OF COMMERCE

Ms. TUTTLE. Thank you, Mr. Chairman.

I just want to start off by saying I think one of the first things I did when I was nominated for this position was to go out to MBS, and I, too, was not only impressed but actually so excited about the kind of research and development that they were doing and what I could see needed to be disseminated and gotten out to businesses. It is very exciting, and I agree, I think it is probably one of our best agencies within the department.

So we are very proud to have them here today, of course, and be a large part of the science and technology functions that we are doing.

I am pleased to be here to discuss the need for reorganizing the science and technology functions of the Department of Commerce. With me today is Dr. Ambler, who will discuss the issues affecting NBS, Barry Beringer, Associate Under Secretary for Economic Affairs, who will discuss issues affecting OPTI and NTIS. Secretary Verity has made this reorganization a top priority of his tenure, and as Secretary, urges the committee to include this proposal as part of the committee's reauthorization of the Department's Science and Technology Programs.

The most basic mission of the Department of Commerce is to foster, promote and develop the foreign and domestic commerce of the United States. Two critical aspects of this involve assisting the development of technology and fostering its efficient utilization by business. As technological issues have become increasingly vital to our economic competitiveness over the last decade, Commerce's involvement has also greatly increased. The Federal Technology Transfer Act of 1986 and Executive Order 12591 have assigned the Department important new responsibilities to facilitate access to research sponsored by the Federal Government. These responsibilities, as well as additional responsibilities assigned the Department in other statutes in recent years involve the Department in a wide range of scientific and technological issues, including extending patent rights to laboratories, universities, small businesses that are conducting Federal research; encouraging government, industry, and university cooperation in research ventures; providing incentives to Federal scientists to commercialize their inventions; conducting research and activities in areas such as computer security, parallel computer networking and superconductivity and encouraging the application of advanced manufacturing technology; developing a central Federal mechanism for the prompt and efficient dissemination of science and technology information developed abroad, and establishing a Malcolm Baldrige National Quality Award to recognize quality achievements of U.S. companies and to publicize successful quality achievement strategies.

I believe our greatest concern today is applying the results of research and development of the benefit of the economy. A straightforward measure of the importance of competitiveness is the U.S. trade balance. Although the trend in trade is now encouraging, the U.S. balance of trade in high technology goods just barely turned positive in 1987, a far

cry from the almost $27 billion surplus we enjoyed in high technology manufacturing in each of 1980 and 1981 years.

This underscores the need for us to bolster our efforts to improve the U.S. international competitive position. the United States makes the world's greatest investment in science and technology, investing $125 billion annually in R&D. About half of this expenditure is made by the Federal Government. With this level of Federal funding, we need to make sure that it provides the greatest benefit to the economy. The administration believes that the transfer of Federal science and technology to the private sector is a priority and should be encouraged by removing unnecessary barriers and providing incentives for commercialization.

In light of the increasing importance of technology to the continued vitality of the economy, Secretary Verity proposes to realign the Department's chief components dealing with science and technology issues, such as a Science and Technology Administration to be headed by a new under secretary. Creation of an Under Secretary for Science and Technology will provide a greater focus on science, technology and competitiveness within Commerce and will allow us to manage these responsibilities more effectively.

At the same time, this proposal will strengthen industry's representation in discussions on technology issues at both the interagency and international levels. Offices reporting to the new administration would be the National Bureau of Standards, the National Telecommunications and Information Administration, the National Technical Information Service and the Office of the Assistant Secretary for Productivity, Technology and Innovation.

This structure will enable the Department to coordinate its broad responsibilities in a more effective manner. The Under Secretary would oversee NBS's basic programs to strengthen and advance the nation's science and technology and to facilitate their application for the public benefit. The Under Secretary would also oversee NTIA's programs to insist in the formulation of policies to support the development and regulation of telecommunications, information and related issues.

NTIS, which is the central source for the public sale of government sponsored research, development and engineering reports, and for other foreign technical reports and analysis, would also report to the new administration.

Finally, the Assistant Secretary for Productivity, Technology and Innovation would be transferred to the new administration and would be responsible for policy analysis in addition to current responsibilities relating to productivity improvement, technological development, and innovation in the private sector.

The proposal does not create any new authorities or functions and does not affect agencies outside of commerce. Moreover, it can be accomplished within existing budget resources through reprogramming of funds. Nonetheless, as technology increasingly becomes the most important factor in determining the long term competitiveness of an advanced economy such as the United States, it is imperative for us to make sure that we as a department have the organization needed to en-

sure the U.S. commercial sector and the economy as a whole benefit from this investment.

In addition to creating the position of Under Secretary, our proposal would also make certain limited changes in the basic authorities of the National Technical Information Service, on of the components proposed to be realigned in the new administration. These changes will maintain the agency within the government, while allowing it to seek an appropriate degree of private sector involvement in the collection, storage and distribution of government technical materials. Specifically, the administration's proposed bill would allow NTIS to carry out any of its individual functions through the use of contracts, grants or cooperative agreements. Such flexibility would potentially encourage the increased U.S. commercial use of federally generated technical materials.

In addition, the proposal would relieve NTIS from the obligation to use Government Printing Office printing services in all cases and would permit NTIS to use monies collected from its operations for the purpose of capital equipment and inventories.

I would like to thank this committee for giving me the opportunity to discuss the need for establishing the Science and Technology administration within the Department. Secretary Verity urges you to include this proposal in the reauthorization of the Department's Science and Technology Programs.

Thank you very much.

Senator ROCKEFELLER. Thank you very much, Secretary Tuttle.

I suppose I ought to ask the obvious question first, which is: with six and a half months or seven months to go in this administration, do you think that doing a major reshuffling within the Department of Commerce, particularly with respect to technical technology areas is a wise idea?

Ms. TUTTLE. Well, as you probably know, this was an organization that did exist within the Department in the 1970s and late 1970s and was changed in about 1981 because of Secretary Baldrige's management style. I think since that time we have seen absolutely a growing awareness of the importance of technology and research and development, and especially in affecting trade issues. We have also seen the President pass certain initiatives on the importance of technology transfer.

So we have seen an increased awareness to raise the visibility of technology, and that is the real reason behind this reorganization.

We also see a need for coordinating better. You know, there is so much emphasis on Sematechs and on these very macro, big projects, but there is not a recognizable entity as to where to go in government for science, research and innovative development. So we felt that by raising the visibility, we think at a very appropriate time because of all the emphasis and awareness on it at this point, we feel that that would be very beneficial in addition to the much better management and organization within the department.

So I do think it is appropriate and very much needed.

Senator ROCKEFELLER. I understand you to mean when you say "management" that if you have four or five areas reporting to an under secretary, a new type of under secretary makes sense. But there are subtle things as well, are there not—I think Mac Baldrige did not favor this concept. He liked to have parts of the Commerce Department report directly to him. For example, while not totally revelant here, I do remember that one of the great successes of the Peace Corps in the structural sense, not in a good "government sense," was that parts of that organization felt that they could go directly to the director. This applied even to eyes-only memos which could just bypass even deputy under secretaries. That sort of sense of closeness, it would seem to me, that while you have made a case for the administrative logic that there is also a morale factor here, there is the sense of closeness to the Secretary. What happens if the Secretary really is interested and really wants to be able to do that?

Now, you put this in place at the end of the administration, what happens if the next administration, maybe the Secretary himself, like Mac Baldrige, wants that hands-on closeness. And perhaps OPTI and others want it too.

Ms. TUTTLE. I would love to make a comment on that. To be quite honest with you, and especially in my position now, seeing how the department runs and knowing how it has been run, at least in the last five years that I have been on board, while in theory it sounds good and you are right, that you would have this direct association with the assistant secretaries rather than one under secretary, in essence it does not work because of time, because of so many other emerging issues, and I think just the opposite happens. I think a lot of the agencies, especially involved in these subjects, actually get ignored because of the low level presence.

There are a lot of levels, for instance, there are a lot of meetings that are held just at the under secretary level and that do not go down to the assistant secretary. In essence, sometimes we really leave out some of these very important agencies.

A good example might even be NTIS which I think has been buried in our department. We think it would be very positive to pull it out.

The second thing—so really, in practicality, I think that an under secretary dealing directly with the Secretary would be able to say, wait a minute, let me tell you about NBS, or let me tell you about NTIA and what is happening.

I understand the concern because I have had that brought up to me, but I think it would get a lot more attention—I have seen it in my previous job as Under Secretary for Travel and Tourism, I had a great deal of attention because of that title, and I think the same thing would happen by creating the level of under secretary, it would give a great deal of attention to these very critical issues.

A second factor would be that in foreign policy, so often they would really like to deal at the under secretary level in any types of negotiations, and a lot of times an Assistant Secretary does not—is not high enough for that attention. So I think that this would benefit us great deal in negotiations with foreign policy.

Senator ROCKEFELLER. Then why—and perhaps you cannot properly answer this, was it that Secretary Baldrige did not want this, that he did see it as a way for keeping close to technology?

Ms. TUTTLE. Well, I understand that for his management style, he did want them reporting to him directly, but in essence, it really did not happen as often as it should have because of just time and busyness of schedule, and I do not think it is as effective as it sounds. I guess that is what I am trying to say. The practicality of it sometimes is not as effective as the theory.

Senator ROCKEFELLER. All right. Let me ask one more question. Then I want to offer Senator Bentsen a chance to say something.

The Japanese technical literature group which is working very hard, and Sabina Javits is really, really working hard on that, is now with the Under Secretary for Economic Affairs.

Is that where this particular group would stay, or would it also come under this new Under Secretary for Technology?

Ms. TUTTLE. It would absolutely come under the Under Secretary for Technology. We think it would be very appropriate in this new division. And again, I think it would have a lot more visibility and it would get more attention, to be quite honest with you.

You know, I have been in the department for five years, and even I was not exposed to all of the research and all of these agencies, and I think they will have much higher exposure.

As you know, we have given NOAA the new title of Under Secretary. I think that has created even a much more visible presence within the Department, and that is our largest agency. I think it is nothing but a positive. I would not be here today, obviously, but I just feel very, very strongly about this.

Senator ROCKEFELLER. Senator Bentsen, do you have any comments that you would like to make?

Senator BENTSEN. Thank you very much, Mr. Chairman.

Having just come into the room, I am not privy to all that has been stated, but I am particularly interested in the commercialization of space, and with so many departments involved, NASA, the Department of Commerce and the Department of Transportation, just what is the authority of your particular department in that regard?

Ms. TUTTLE. I know there have been several questions on this, so I would be very pleased to answer it.

We see space as another sector in the economy. We see it has great potential for commercialization and great use by the private sector, and our role would be to work with the private sector in seeing if they would get into the business of commercialization of space.

Other countries have been doing this. France has been very successful in commercializing their space program for research, in the areas of research.

Senator BENTSEN. Let me ask you, how successful have they been recently? Have they not had some problems with some of their launches?

The CHAIRMAN. I had a report, and I wish I had the title of it, that showed that they are booked up for the next five or ten years by private companies who would like to rent space on their platform.

Senator BENTSEN. I understand that, but did they not have some launching problems that delayed them and gave them some of the same concerns we had?

Ms. TUTTLE. They might have had. You know, I really don't know that, but it has been a very successful program.

We now see states, obviously, you know that Florida and Hawaii are looking into the idea of developing a platform and opening up to businesses.

Senator BENTSEN. The reason I am asking you is that, I was talking to someone from the private sector who is trying very much to get a launch. He had told me, I think I remember, about an explosion in the French program, and a very substantial delay as a result of that.

Ms. TUTTLE. I am sorry, I do not have information on that.

Certainly we know that Australia is getting to be very involved with this. I think as we see other countries developing the commercialization of space, we certainly would be ourselves a user of that platform. We would be conducting, NBS would be conducting certain research, microgravity research on that. NOAA certainly would have some experiments on it. So we even would see the benefits of it as a user.

Senator BENTSEN. I am advised that in your testimony you were talking about the great importance of high technology and that the balance of trade shows us something of our competitiveness or our lack of competitiveness in that regard.

You were talking about Malcolm Baldrige earlier. On the Monday morning after he lost his life, I had on my desk a personal, handwritten note at the top of my paperwork thanking me for the work we had done together on the trade bill. I happen to think it is awfully important to the competitiveness of the country.

Why do you not get him to sign it?

Ms. TUTTLE. What can I say?

Senator ROCKEFELLER. Within the context of that question, Secretary Tuttle, as Senator Bentsen said, there was a lot of cooperation between the Commerce Committee and the Department of Commerce in putting the various aspects in the trade bill that reflect our work here.

If unfortunately the trade bill were not to survive—and this is a question for the record—and if we were to separate out that part of the bill which related to technology and send it to the President separately, would you and Secretary Verity recommend that he sign it?

Ms. TUTTLE. As you know, the administration did not oppose that at all in the bill and I think were supportive of it. It is something that I would like to go back, before giving you a definite answer, and present it to OMB as a separate portion, and I really would have to do that first before giving you a very definite answer.

Senator ROCKEFELLER. Just one final question.

The Continuing Resolution for fiscal year 1988 contains $5 million for the National Bureau of Standards to start regional centers for the transfer of manufacturing technology which, everybody agrees, is an enormously important purpose. Yet Secretary Verity in a May 12 appearance before the Senate Appropriations Committee said that the Federal Register notice necessary to start the center program was still at the Office of Management and Budget.

Is OMB still holding that Federal Register notice?

Ms. TUTTLE. They are. It is still in OMB.

Senator ROCKEFELLER. What do you think are the reasons for the delay?

Ms. TUTTLE. I do not know. I could tell you maybe Monday after I have a meeting. We are trying to clear it up and either way get the decision moved, and so it is something that I will be seeing with OMB next week on it.

I would be very happy to get back to you personally on it.

Senator ROCKEFELLER. I would hope very much that you would.

Ms. TUTTLE. I will.

May I just go back to one other point, because I think this question about would the agencies be buried, and how much access would they have to the Secretary, I know it is a concern, so I want to draw another parallel, which I think is a very good example would be ITA's structure. ITA, as we all know, is headed by a very strong under secretary, but the assistant secretaries within that organization are very strong, very independent. They have just as much direct access, they have the ability to go to the Secretary as much as the under secretary, and they do at times. Most often the under secretary could be busier on another project, and it is the assistant secretary who is briefing or talking to the Secretary on a direct subject.

And I think that that same kind of format would be available. I mean, just because we have created an under secretary would not mean that an assistant secretary cannot go and see the Secretary.

I would also like to give the example that Al Sikes, the Assistant Secretary Al Sikes for NTIA, is out of town right now but is very supportive of this project, has given us a great deal of backing and wording as to why he thinks it would work for NTIA, and I respect his opinion a great deal, and he is very much for it.

I just wanted to add that.

Senator ROCKEFELLER. Fine.

Secretary Tuttle, I thank you very much for your courtesy in being here and being so well informed.

Ms. TUTTLE. Thank you for holding this hearing. Thank you very much.

Senator ROCKEFELLER. Before moving on I should mention that we are going to have a series of votes at 11:30, four votes at ten minute intervals.

The first panel is Dr. Ernest Ambler, of the National Bureau of Standards, who is accompanied by Dr. Leslie Smith, and Mr. Barry Beringer, Associate Under Secretary for Economic Affairs, Department of Commerce.

I want to say that for the record here, that Dr. Donald Johnson, Director of Technology Services Task Force, National Bureau of Standards, was due to be at this panel, on this panel, this morning, and was not allowed to come by OMB. This is very distressing to the Commerce Committee. To be quite honest, some people were annoyed enough that they thought perhaps we would have nobody from the administration come if he was not allowed to come.

The Department of Commerce had nothing to do with that. That was an OMB decision that Don Johnson could not come, and I think a most regrettable one.

But we are glad that you are here and welcome your testimony.

Dr. Ambler, we are delighted to hear from you, sir.

STATEMENT OF DR. ERNEST AMBLER, DIRECTOR, NATIONAL BUREAU OF STANDARDS; ACCOMPANIED BY DR. LESLIE SMITH, CHIEF, PROGRAM OFFICE,

Dr. AMBLER. Thank you very much, Mr. Chairman.

With your permission, I would like to summarize my remarks and submit my written statement for the record.

Accompanying me is Dr. Leslie Smith who is Chief of the Program Office of the National Bureau of Standards.

I am pleased again to appear before you to request authorization of appropriations for the National Bureau of Standards for fiscal year 1989. This year the President is requesting $158 million for the National Bureau of Standards, an increase of $13 million over the fiscal year 1988 appropriation.

This increase follows an increase of 17 percent for NBS in fiscal year 1988.

The administration, Congress and the public at large are determined to keep America's economy healthy and to make it truly competitive in international markets. The favorable treatment of the NBS budge request reflects, I believe, the importance of the NBS mission in supporting industry, and I was extremely gratified, Mr. Chairman, about what you said about NBS in your opening remarks.

Deputy Secretary Tuttle has just said that she believes the greatest concern is in applying the results of R&D to benefit our economy. Measurements are the link between basic research and industrial applications of technologies. They help put our scientific advances to productive use. NBS measurement research and services improve on-line quality control, increase industrial productivity and speed the acceptance of new products in the marketplace.

At NBS we are concentrating our attention on emerging technologies because of the leverage they offer for improving the U.S. competitive position in world markets.

We are asking for increases in the number of emerging technology areas that will improve U.S. competitiveness. Measurement research in high temperature superconductors, light weight measurement technology, high performance composites, bioprocess engineering, and chemical process and control and quality assurance.

In addition, increases are requested for computer security and to implement the President's proposed Thomas A. Edison prize.

We have learned a great deal over the last two decades about how to move the results of R&D into the private sector. Institutions such as NBS that have been active in technology transfer understand a great deal about the process, what works and what does not work.

NBS has always worked cooperatively with the private sector. I have described for this committee many times the numbers and kinds of cooperative arrangements we have with industry, and I have done so again in my written statement. State and local Governments, being closer to their local industries and identifying more closely with their aims and objectives, may understand economic growth better than the Federal Government ever can.

I would like to close by making four points about the Federal role in science and technology to support U.S. competitiveness.

First, many serious, nontechnical barriers to improved competitiveness remain, the so-called macroeconomic barriers that include capital formation, tax policy, the regulatory environment, trade policies of other countries, and intellectual property laws.

Second, technology transfer is no easy task. It cannot be taken for granted. We have come a long way, but we still need to use our creativity to study and improve the process.

Third, while many of the federal laboratories can and should play an important role in supporting industry, the Government has never been successful in showing industry how to do its job, and there is absolutely no reason to think that this will change in the future. Developing products and getting them ready for market is the private sector's job, not the Federal Government's.

Fourth, no amount of Federal activity will substitute for private sector leadership and action in this area.

Thank you very much, Mr. Chairman, for this opportunity to appear before you. I will be happy to answer questions.

[The statement follows:]

STATEMENT OF ERNEST AMBLER, DIRECTOR, NATIONAL BUREAU OF STANDARDS, DEPARTMENT OF COMMERCE

Mr. Chairman and members of the Commttee, I am pleased to appear before you today to request authorization of appropriations for the National Bureau of Standards [NBS] for fiscal year 1989. Accompanying me today is Dr. Leslie E. Smith, the Chief of the NBS Program Office.

I believe our greatest concern today is in applying the results of R&D to benefit our economy. In this regard, we think we are a perfect fit for the Department's new Science and Technology Administration which is being proposed by President Reagan and Chairman Hollings.

At NBS, we have always worked cooperatively with the private sector. In fact, we like to say that cooperative research is a "way of life" at NBS.

We do this in a variety of ways. NBS has a research associate program through which sponsoring firms or organizations pay the salaries of some 200 researchers each year while they work with NBS staff in NBS laboratories on projects of mutual interest. Companies that join this program can retain exclusive rights to patents which occur as a result of the cooperative research. This program also allows us to conduct some research that we otherwise could not do. Technology transfer is built in from the beginning with the definition of the work to be done and by establishing personal contacts. Aggressive implementation of the Federal Technology Transfer Act—P.L. 99-502—will facilitate such cooperation.

We also host top scientists and engineers from industry and universities for various durations in a less formal way through a program for guest researchers. About 800 such experts come to our laboratories each year with a blend of academic, government, and industrial research interests.

Another way in which we collaborate with industry, one that may be unique in the Federal Government, is a cost-sharing mechanism. Many companies loan or donate to NBS equipment or materials for experimentation. Last year, we had nearly $19 million worth of equipment and materials either loaned or donated to us by dozens of companies. It is not just the big companies that are chipping in, either. Contributions range from $500 worth of precision ball bearings to $3.5 million of computer equipment. The automated manufacturing research facility is a prime example of this creative cooperation.

In addition to arrangements with individual companies, we have also formed research consortia and other cooperative arrangements in just about every way possible. These involve groups of companies, and sometimes agencies, which often pay a share to have NBS conduct research for the group. In other cases, NBS plays a lead role in organizing—and helping to keep together—groups of interested firms and agencies in cooperative work where no funds are exchanged and each party contributes its own time and effort.

Our facilities are a key drawing card for attracting companies to NBS in a way that encourages technology transfer. We have had a long-standing policy permitting NBS facilities to be used for collaborative research. For instance, more than 300 specialists from industry, universities, and other government agencies use our nuclear research reactor each year. We expect more demand once the cold neutron source is installed, allowing state-of-the-art analysis of the structure of new leading-edge materials. This will be the only facility of its kind in the United States. It is being established as a national user facility in recognition of the growing need to help put the best facilities at industry's disposal. We make such facilities available at cost for proprietary research.

We also use workshops, conferences, and participation in standards committees as a way to work with individual scientists and engineers in identifying and solving problems. We held more than 100 major conferences and 600 workshops and seminars last year, bringing together thousands of experts from around the world. Our employees had more than 1,400 memberships on standards committees. In most of those meetings, NBS researchers sit alongside industry experts, contributing their technical expertise and listening to what industry says it needs from NBS.

We have scores of other examples of successful technology transfer through cooperative work. At last count, we had about 250 active, formal collaborative projects. We are constantly in search of new partners for research that will help both NBS and the private sector to accomplish their goals. A quarter of our technical collaborations are with small businesses. In addition, we reach a large number of small businesses through the larger firms to which they are suppliers and subcontractors. We have published a special brochure that describes many of the opportunities for cooperative research at NBS.

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The administration and Congress are insisting on obtaining the maximum commercialization of Federal R&D results through decentralized technology management throughout the government. Consequently, the department of commerce has delegated authority to me and I in turn have delegated authority to the four major operating units of NBS to act as laboratories under the Federal Technology Transfer Act. This will facilitate technology transfer from NBS to the private sector.

This year the President is requesting $158 million for the National Bureau of Standards; an increase of $13 million or 10 percent over the fiscal year 1988 congressional appropriation. This increase follows an increase of 17 percent for NBS in fiscal year 1988 over the fiscal year 1987 appropriation. This unprecedented recognition of the importance of the NBS mission to improve industrial productivity and quality control is most gratifying. The administration, Congress and the public alike are determined to keep America's economy healthy and to make it truly competitive in international markets.

Emerging technologies provide strong leverage for the United States to improve its competitive position in world markets. Emerging technologies are most likely to lead to innovative products and services. Measurements are the link between basic research and industrial applications. They help put our scientific advances to productive use. NBS measurement services speed comercialization, provide on-line quality control, and increase industrial productivity. We are asking for increases in a number of emerging technology areas that will improve U.S. competitiveness: measurement research in high-temperature superconductors, lightwave measurement technology, high performance composites, bioprocess engineering, and chemical process control and quality assurance. In addition, increases are requested for computer security and to implement the President's proposed Thomas A. Edison Prize.

Before I describe these expansion areas for NBS, Mr. Chairman, I would like to make four final points about the Federal role in science and technology to support U.S. competitiveness:

First, many serious nontechnical barriers to improved competitiveness remain. The so-called "macroeconomic" barriers include capital formation, tax policy, the regulatory environment, trade polices of other countries, and intellectual property law.

Second, technology transfer is no easy task; it cannot be taken for granted. We've come a long way, but we still have things to learn.

Third, while many of the Federal laboratories can and should play an important role in supporting industry, the Government has never been successful in showing industry how to do its job, and there is absolutely no reason to think that this will change in the future. Developing products and getting them ready for market is the private sector's job, not the Federal Government's.

Fourth, no amount of Federal leadership will substitute for private sector leadership in this area.

Proposed increases to the Bureau's fiscal year 1989 budget include a $6.5 million increase for high temperature superconductors which builds on the $2.8 million appropriated in 1988 and is being used to start the NBS part of the President's superconductivity initiative. As one of the major scientific breakthroughs of the century, extraordinary international competition is under way to apply superconductivity concepts to new products. This initiative will allow NBS to provide U.S. industry with research results and measurement techniques needed to develop and commercialize products based on new high-temperature superconductors. The program will establish a center of excellence at NBS for electronic applications of superconductivity. NBS products will include measurement methods, standard reference materials, and devices for measuring weak magnetic fields.

Ligthwave technology is the basis for a worldwide $2 billion-a-year industry. International competition is intense and focuses on optical fibers and opto-electronic components which send, receive, managed, and process the signals carried by optical fibers. The United States faces formidable competition in pursuit of this enormous world market. The $3 million request for fiber optics will expand the program begun by NBS in fiscal year 1987. This program will provide measurement capability that U.S. communications and computer firms need to develop and sell internationally competitive opto-electronic components.

The requested increase in high-performance composites provides the second increment of funding for the program started in fiscal year 1988. Efficient commercialization of advanced composite materials is tied to increased reliability at lower unit cost. The inability of current manufacturing techniques to adequately control fiber/matrix adhesion and other interface features is a major barrier for industrial fabrication of reliable composites. NBS will carry out research to better control materials

behavior during the manufacturing process and to predict the performance of composites in use.

The United States is the world leader in fundamental biochemical research and innovation in the laboratory, but is behind world competition in extending this technology to the marketplace. NBS measurement tools and data are aimed at helping U.S. industry to accelerate the commercialization of bioproducts and to penetrate the world biochemical market. A two and a quarter million dollar increase in this bioprocess engineering initiative adds to the $1 million appropriated in fiscal year 1988. The focus will be on engineering data and procedures needed by industry to convert successful laboratory innovations in bioprocessing into commercially viable manufacturing processes.

Two and one-half million dollars will be used to expand the Bureau's work on process control and quality assurance into the chemical industry. Up to now, the initiative has focused on physical measurements. An accurate measurement system is needed for the tens of billions of analytical measurements made yearly in the United States. For many emerging technologies no chemical measurement base exists. This increase will allow NBS to advance chemical measurement science needed for new high-technology industries and to improve the quality assurance of chemical measurements.

The Computer Security Act of 1987 (P.L. 100–235) gives NBS primary responsibility for developing standards and guidelines needed for the cost-effective protection of sensitive, unclassified information in computers throughout the Federal Government. With this increase, NBS will expand its laboratory-based program involving research, standards development, and technical assistance and will carry out the requirements of the new legislation.

The President has proposed a $4 million increase for a Thomas A. Edison Prize to spur inventors toward new technologies that could have great public benefit, but not necessarily strong market reward. These technologies and inventions could improve the quality of life in this Nation and the world. NBS would administer this program, which would offer monetary incentives.

We are also proposing decreases to combine the fire and building programs into a new fire and building center which would receive a $5 million appropriation to continue efforts directed at health- and safety-related research such as earthquake hazards, structural safety and engineering, toxicity of combustion products, and computer modeling of smoke and fire spread.

Finally, Mr. Chairman, there is one other issue that is not in the budget as it is fully supported by the private sector. We have worked very hard on this program which we believe to be symbolic of the goals toward which we all are striving. Industry and government have joined together to establish the Malcolm Baldrige National Quality Award to, in the President's words, "salute companies that improve the quality of their goods and services, thus enhancing productivity, lowering costs, and increasing profitability". The first awards will be made by President Reagan in November.

I want to emphasize that quality is more than a public relations slogan. It is solid, hard work and attention to detail by everyone involved. We have to focus on finding and promoting ways to build quality and reliability into the product. Such quality control systems will allow technological changes to be readily incorporated to gain maximum performance at minimum cost.

Thank you for the opportunity to appear before you, Mr. Chairman. I shall be glad to answer any questions you may have.

Senator ROCKEFELLER. Thank you, Dr. Ambler, and we will have questions.

Mr. Beringer?

STATEMENT OF BARRY C. BERINGER, ASSOCIATE UNDER SECRETARY FOR ECONOMIC AFFAIRS, DEPARTMENT OF COMMERCE

Mr. BERINGER. Thank you, Mr. Chairman.

I am here today to discuss the authorization request for Economic Affairs' science and technology programs. These are the Office of Productivity Technology and Innovation, the National Technical Information Service, and the Office of Japanese Technical Literature. And I would also like to discuss the way in which these programs will be integrated into the proposed Science and Technology Administration.

During the past seven years, the Department of Commerce has taken a lead role in the transfer of our federally funded technology to the private sector. This is an appropriate role for the Department of Commerce because much of today's federally developed science and technology holds the potential for becoming tomorrow's products. The time in which an invention goes from the laboratory to the marketplace is continually shrinking.

As Deputy Secretary Tuttle has testified, the Department wishes to provide a greater focus on science, technology, and competitiveness and to strengthen its leadership in the management of federally funded technology by creating an Under Secretary for Science and Technology. This will bring together under single management all Commerce Department policy and programmatic functions which promote the Government's efforts to facilitate rapid transfer of technology to the U.S. private sector in order to bolster our country's international competitive position.

As we know, the U.S. invests more in R&D than any other nation, but concerns remain that the U.S. lags behind in the pace in which it translates U.S. research into new products and processes. As the Governmentally funded science and technology base of the world is growing, it is vitally important that our Government make this resource available in an efficient and timely way to the private sector. U.S. leadership in science and technology should mean leadership in U.S. commerce as well. It is the private sector, as Dr. Ambler points out, which does the actual commercial development of the processes and products which are invented in their own or Government funded research establishments.

A prime mission of Economic Affairs' Science and Technology Programs has been making the linkage between Government funded research, whether domestic or foreign funded, and the private sector.

The Office of Productivity, Technology and Innovation has taken a lead in developing policies for reducing Governmental barriers to the rapid commercial use of science and technology by the U.S. private sector. With the help of Congress, especially leadership from this committee, OPTI has advocated the removal of antitrust barriers to cooperative research, an effort which led to the adoption of the National Cooperative Research Act.

It has called for private sector research to be enhanced through research and development tax credits, advocated making contactor ownership of the results of their federally funded research a Government policy, and most recently, aided in the implementation of the Federal Technology Transfer Act of 1986.

Consistent with Secretary Verity's approach for the whole department for fiscal year 1989, a streamlined OPTI will become the policy analysis office of the new Under Secretary for Science and Technology, and thus continue to be the department's focal point and advocate on policy matters involving productivity, technology, and innovation.

It will also continue aiding in the formation of cooperative R&D ventures.

Secretary Verity has also recently created a new Office of Federal Technology Management which will take the lead role in the new Science and Technology Administration in the management and implementation functions given the Secretary under the Federal Technology Transfer Act, the Bayh-Dole Act and the Trademark Clarification Act of 1984.

Another vital part of the new Science and Technology Administration is the National Technical Information Service. The Department of Commerce is determined that the future operation of the National Technical Information Service be as carefully and thoroughly planned as possible. We have proposed legislation that makes certain limited changes to the basic authorities of NTIS that will maintain the agency within the Government while allowing it to seek an appropriate degree of private sector involvement.

Specifically, the administration's proposed bill would allow NTIS to make flexible use of contracts, grants or cooperative agreements with the private sector, individual firms and other organizations, procure printing services without regard to Section 501 of Title 44 of the U.S. Code which requires the use of the Government Printing Office.

Also our bill proposes to use its receipts for the purpose of acquiring capital equipment and inventories.

NTIS also takes a lead role in obtaining foreign technical documents and making them available in the United States. It has worked closely with the Office of Japanese Technical Literature which was established in June of last year by Under Secretary for Economic Affairs Bob Ortner. Staffed by two Japanese speaking professionals, this office is responsible for coordinating all activities carried out under the Japanese Technical Literature Act. It also serves as the central point of contact within the Department and with other federal agencies and departments on activities related to the acquisition and dissemination of Japanese technical literature.

Our approach in implementing the act has been to increase awareness of existing resources for Japanese technical information, to provide appropriate information where gaps exist, and to coordinate current Federal Government efforts in order to avoid dupplication. The Office has accomplished the following in fulfillment of the requirements of the Japanese Technical Literature Act: publication of the first annual Director of yJapanese Technical Resources; publications of reports on high technology developments in Japan, including ceramic and semiconductor sciences and flexible manufacturing systems; completion of a report to Congress on all Federal Government activities to acquire, abstract, translate and disseminate Japanese technical literature; comple-

tion of a survey of industry demand for Japanese technical information in the field of advanced ceramics; and with the Office of Naval Research and the Department of Energy, cosponsored a conference on high technology materials in Japan.

Consultations are under progress with other Government agencies and industry regarding the establishment of an office presence in Tokyo for Japanese technical literature.

The administration is asking for an authorization of $2,007,000 for the Office of Productivity, Technology and Innovation. This figure includes $300,000 for the Office of Strategic Resources.

We are also asking for no funding for the National Technical Information Service for the Patent and Licensing activity. NTIS is self-supporting and under the Federal Technology Transfer Act, the Patent Licensing program is now receiving fees from reimbursible agreements with other agencies for whom NTIS provides patent license management services.

For the Office of Japanese Technical Literature, we are requesting an authorization of $425,000.

Thank you, MR. Chairman. I will be glad to answer questions.

The CHAIRMAN. Thank you, Mr. Beringer, and we will have some for you in a moment.

Dr. Ambler, a little later on in this hearing, OTA will summarize the findings of its new report on advanced materials, which is a report, incidentally, that this committee requested of them.

The report suggests that the advanced materials market in the United States will grow from $2 billion to perhaps $20 billion or more by the year 2000, and I have heard higher figures. The Japanese are pursuing this technology, as we all know, very aggressively.

I would guess that America lags behind at this point. We particularly lag in developing rapid low cost ways to manufacture these new facilities.

What is the Bureau of Standards doing in the advanced materials field, and what if anything can you do to help American industry try to get competitive with our Japanese competitors in this area?

Dr. AMBLER. Well, a component of our program is in materials research, science and research, and our program is focused on those very advanced materials. It is part of our overall strategy to focus on emerging technologies, and certainly advanced materials are a grouping of extremely important emerging technologies.

For example, we have focused on ceramics, focused on composite materials, focused on polymer materials of different kinds, and we are providing the basic information and services that we normally do.

So I would say we are responding by focusing our whole materials research program along those lines. Of course, I have not seen the report, but from the way you describe it, it sounds very similar to the kind of thinking that we have been doing in our own planning.

Senator ROCKEFELLER. But candidly, Dr. Ambler, I mean, where are we in this country in either Government research and/or private corporate research or university research? I mean, I know that there are a

variety of universities, including the University of Delaware, that do good work in this area, but in comparison to the Japanese and the efforts that they are making, where do we as a country stand with respect to advanced materials?

Dr. AMBLER. Well, I think I can answer that question best by saying in the area of advanced materials, the position that we find ourselves in is no different than any other area of emerging technology, whether it be optical communications or whatever.

And it is my view that although there is no occasion for us to be complacent about our R&D, when it comes to the basic research or the forefront research, we are not behind in very many areas, and we are ahead in most areas. But the area where we do not do very well, which is the critical area for commercialization, is the speed that we take the results of research, the new, emerging technologies, and apply them into products and processes. It takes us far longer than it takes the Japanese. We seem to be unable to do it with the skill, efficiency and speed that they do.

Senator ROCKEFELLER. Well, let's pursue that for a second.

I have been with you at the National Bureau and looked at what you are doing there, and it is impressive. You know that, most of what—all of what you are doing, as far as I am concerned, is very impressive, and I think it is, it is a national treasure that ought to be better known.

Relatively few Senators, as far as I know, have been out there to visit you. Hopefully more have come since I was there, and others hopefully will come,. But you know, I do not agree with an assessment that says that we are comparable with the Japanese in terms of research and development but, much less comparable in terms of making it a commercial process. Be that as it may, why is this so? Why do we have this gap between development and being able to commercialization?

And regardless of what your answer might be to that, what is it that you can do or that the Federal Government ought to help to close that gap?

Dr. AMBLER. I think I came as close to answering that question to the best of my ability in a report that Mr. Brown, who at that time was Deputy Secretary of Commerce, asked me to do within the department on Emerging technologies. He asked us first to enumerate the emerging technologies. He asked us then to prioritize them into their relative importance, and he then asked us to answer the question, well, what is it that would prevent the United States from exploiting them quickly and therefore using them effectively in competitiveness, and we did that, and there were a number of reasons, and the members of this committee were from different agencies in the Department, and some of them are of a marcoeconomic kind and some of them are of a management kind.

The ones that I feel I can only speak to authoritatively are the ones that tend to be the use of technology, which is not by any means the only problem area.

But all of then are things that the Federal Government can do something about.

One of the things that would appear would be the cost of capital to our businessmen compared to the cost of capital in Japan. Japan seems to be able to cooperate much better than we do. We are not brought up to cooperate in this country; we are brought up to compete, and we do not cooperate very well.

Government and industry have never been—well, industry has never been a great admirer of the Government, and perhaps vice versa. I do not know.

But the companies themselves cooperating is not something that has been—of course, antitrust has had a lot to do with that, but now that seems to be changing somewhat, and you are getting things like Sematech.

I think we are——

Senator ROCKEFELLER. But do you push yourself and your research and development and your ability to try and commercialize that, or do you sit there waiting for American industry to come to you? How does it work?

Dr. AMBLER. I push. I have been giving more speeches lately and frankly, I have been more outspoken than I have a reputation for being, following this theme that I mentioned in my testimony. I mean, it is all very well to say what is the Federal Government going to do about the trade deficit. the Federal Government is, in my opinion, impotent to do anything about the Federal trade deficit if our manufacturers cannot make exports greater than importers. And the Federal Government does not make anything, it does not sell anything. It can help, it can support.

So I think that the heat, really, the focus is on the private sector, and it is up to the private sector to demand from Government what it needs to get the job done.

Senator ROCKEFELLER. But that is interesting. With respect to the Japanese Technical Literature Act which I will be talking with Mr. Beringer about, I hear well known people high up in corporations saying, well, we really do not need anything that the Japanese have put out. I hear this directly from them. It seems that American corporations, at least with respect to Japanese research in a variety of fields are not interested in their innovations. Now, I am not saying this is totally uniform, but I hear it enough so that it is extremely discouraging. And there is the additional fact that the one private service dedicated to translating Japanese technical information, went out of business because they could not make money, which means that corporations were not coming to them for that type of information. They did not feel it was important.

Now, I think there is a direct comparison between this attitude, and, let's say, advanced materials. I have heard figures much higher than the ones I gave here. I have head that globally advanced ceramic materials could be a $200 billion, $300 billion, or $400 billion industry in 15 years. And so you say, I give speeches to try to get industry interested

but its still up to American industries to decide to come for help when they feel appropriate.

Now, our theory in this country is kind of a Lone Ranger theory, that a businessman who is an entrepreneur goes out and discovers something, and then we all admire him. There is nothing about cooperation or getting on with other people or the Japanese style.

But we have come to the point now where, if we are not in the lead or at least up with the Japanese on advanced materials, it is really dangerous. I mean, it is a real bad sign for our future.

Don't you think we have to do more, that we have to do more about getting information out to American industry, or are you doing the best you can, and you simply cannot get any more interest?

Dr. AMBLER. Well, I think we have to do more, and we will do more.

And I am not trying to speak against that, but the point I am trying to make is that the situation that you describe in my view is unacceptable. And if that attitude were to be pervasive, no amount of what we produced would do any good because you are force feeding a horse that does not want to eat.

We have got to secure a greater cooperation between the private sector and the government, a greater mutual acceptance, and make it clear to the private sector that exporting is their business, and competing with the Japanese industry is their job. And the government is there to help and will help and, you know, advertise all of the things that we can provide. But to take the point of view that, you know, you can do something within the government and then suddenly that will make the difference is very suspect in my view.

I have worked with the private sector a very long time. I have thought about these issues a very long time, way back when Congressman Brown in the House was raising these issues, and I have never felt that the government, you know, can show industry what it is that they are constituted to do. They can urge them and point out to them what it is they are supposed to do and offer help.

So I have—I mean, maybe you think that speaking out is pretty weak, but——

Senator ROCKEFELLER. No, I was not saying that, Dr. Ambler. I am just frustrated. I am just frustrated by the response of American industry. Evidently you are, too. And you know, you cannot—you can write and speak and that is about all you can do. You cannot make it mandatory.

I know, Mr. Beringer, I think you wanted to say something, or at least, if you did not, I would like you to.

Mr. BERINGER. I think we are starting to realize the benefits of cooperation, and as I had mentioned earlier in the testimony, with the leadership of this committee and the Judiciary Committees of both Houses, why, we passed the National Cooperative Research Act.

There has been about 73 consortia formed to do joint research and development in many fields, including advanced materials research under the National Cooperative Research Act, but it is a slow educational process to get this thought across because, as Dr. Ambler

points out, this is not the traditional American way, United States way of doing business, and I think what we are all searching for in our frustration is a unique American model, as you say, not to copy the Japanese, but a unique American model of government-industry cooperation.

So we are doing better. We need to do more.

Senator ROCKEFELLER. Why did that company go out of business?

Mr. BERINGER. Why did UMI go out of business?

Senator ROCKEFELLER. Yes.

Mr. BERINGER. The demand was not there, as you said.

Senator ROCKEFELLER. Well, why was the demand not there?

Mr. BERINGER. We, as I noted earlier, have done a survey of one particular segment of industry as to their uses of Japanese technical literature, the advanced ceramics, and we have discovered that it is very uneven between different companies, and it depends upon largely the leadership of the company and the technology managers.

A lot of companies, and this is what we are trying to determine now, actually have presence in Japan. So a lot of the more enlightened companies such as General Electric, if you will have people over there collecting material for their own benefit, and naturally they do not go out and tell their competitors this is what we are doing.

UMI was also a very ambitious project. They had—it was part of Xerox at one time, was part of Bell & Howell. They had invested millions of dollars over the past several years in trying to put together a full service product of all Japanese technical literature. That may not be the way to go about doing things. There are more companies now coming out that have what I would call niche products, that concentrate on semiconductors, that concentrate on consumer electronics, that concentrate on supercomputers, that have special reports in these areas, and it may be a better approach. And we are working with these groups, a better approach to try identify a limited segment of the market and then try to sell their products to the same segment of the market which is their counterpart over here.

So UMI was the premier example, but in our directory of Japanese technical resources, we list, I do not even remember the number, it strikes me as several hundred different translation services and their technical expertise. So it is available, and I think everyone is searching for a way, the best way to make the information available.

Senator ROCKEFELLER. Thank you.

Dr. Ambler, another question.

According to a recent report by the American Electronics Association, the Japanese MITI is going to start, as I said in my opening statement, a ten year, $112 million next generation technology product on superconducting materials and devices.

Much of the research will focus on technologies needed for the creation of a superconducting computer, including design, including fabrication and process technology for mass production, which is what we are talking about.

Now, I know that our research system differs from Japan's. We have discussed that. But is anybody in the United States conducting equivalent research in methods to design to fabricate and to mass produce superconducting devices? Is there any reason to believe, in fact, that we will not lose this new technology to the Japanese just as we have a number of others in your opinion, sir.

Dr. AMBLER. Before I answer that question, I might point out that in this particular area, as with some of the materials areas, the Bureau if asking for appropriations. I guess I was getting a little general in the answers that I have given you and forgetting the fact that I am here to request authorizations of appropriations for the Bureau of Standards, and we are in fact in our budget request addressing to our best ability those areas as we are in the area of superconductivity.

From what we can make out in the research areas in superconductivity, the two countries are neck and neck. They are both going very fast. There is the appreciation here as well as there that the use of superconductors first in just wiring up integrated circuits so they become faster is of great important, and perhaps later on to have circuits themselves. That is an area not so much for computation but similar area related to instrumentation where you use very similar circuits.

So the Bureau has been active in it. In fact, before this recent discovery of high temperature superconductors, after IBM stopped its programs in Josephson junctions, we had the biggest research program because we used them in voltage standards and various kinds of detectors.

So I think that from a research point of view things are neck and neck.

Will we lose out? I guess unless we learn the antidotes to the Japanese techniques of capturing markets the way they have, you would have to way history shows that we will. But if we deploy the kinds of ideas and enthusiasm that is springing up now in the country and learn how to work cooperatively and get more serious about the whole thing, we will reverse the trend in—well, we will not let the trend occur in superconductivity, and we will reverse it in other areas.

Senator ROCKEFELLER. The Defense Department has released $100 million to Sematech, and I would be interested to know what role that NBS will play with Sematech, particularly in precise measurement methods and process techniques necessary to make new computer chips reliably and cost effectively.

Dr. AMBLER. Yes, we have been talking extensively to Sematech. We do not have any funds at the moment, but we hope and expect that we might, and we have made it very clear to them what we can do for their program.

Senator ROCKEFELLER. What have you been taking to them about?

Dr. AMBLER. About measurement techniques and quality control.

Senator ROCKEFELLER. So you see a strong future cooperation with them.

Dr. AMBLER. I would hope so, yes.

Senator ROCKEFELLER. Good.

Last November the White House Office of Science and Technology Policy issued a major report calling for a new national research strategy to help develop the next generation of high performance computers, and this was drafted by an interagency committee which included your shop. The report calls for a major new five year effort by government and industry alike.

What steps has the administration taken to implement the recommendations of this report. For example, do you expect the President to request in fiscal year 1990 funding to begin this major research effort, and what role would you like the Bureau to play in this effort?

Dr. AMBLER. It is my understanding that there is a proposal for a program at the level of $2 billion over five years that will involve the Department of Energy and DARPA. I do not know whether this is intended to propose this as the budget initiative in 1990, but the plans are there at any rate.

And Dr. James Burroughs, the Director of our Institute for Computer Science and Technology, was active on the various committees that led up to that, and we made it clear the kind of role that we can play here for some time, which has to do with how you determine that the performance of a supercomputer, the kind of machines that they are talking about, highly parallelized, and different kind, and that we will need different ways of assessing their speed and capabilities. That is the aspect of it that we would hope to work on.

Senator ROCKEFELLER. Dr. Ambler, I have just one final question for you and it is about computer viruses. These are programs that can sabotage entire computer systems, and we have learned that computers, including federal ones, are highly vulnerable to unauthorized access and disruption.

Now, we have the Computer Security Act of 1987. Your Bureau has major new responsibilities to help other federal agencies safeguard their computers and their computer information. You have also requested $3 million in fiscal year 1989 to help to implement that law.

What will you do with the $3 million, and how do you see the future of this problem?

Dr. AMBLER. What we expect to do is to develop the kind of procedures and standards for assuring security, to make those available to the government and elsewhere through workshops and training sessions, and in all of this we will work closely with the National Security Agency, and we will work closely with other federal agencies to apply the appropriate and best security techniques to federal computers.

Senator ROCKEFELLER. Well, how serious is the problem? I mean, $3 million does not sound to me in government terms like an enormous response if it is a huge problem. I do not happen to know how huge a problem it is, and it may be perfectly possible that $3 million is thoroughly ample to do whatever has to be done to stop it.

Dr. AMBLER. Well, first I would like to say that OMB has agreed that we will ask for a further $2 million in the next budget so that with the $1 million we already have, it will be a $6 million program.

Senator ROCKEFELLER. Well, then, three, six, five, four, whatever. I mean, how serious is it and how do you stop it?

Dr. AMBLER. It is my impression that it is not a critically serious problem.

Dr. SMITH. Maybe I can answer that, Senator.

Computer viruses are just another form of risk that computer systems are going to have to learn to deal with, and this is not going to be a problem which can be solved in any definite sense. In other words, for every countermeasure that software designers develop to guard against computer viruses, clever hackers, if you will, will develop yet another technique to overcome them.

Senator ROCKEFELLER. And it really does work that way. It really is just incredibly highly integrated chess.

Dr. SMITH. We think it is going to just continue almost indefinitely. that does not mean there are not things being done about it. People are developing software responses to these kinds of viruses, but we do not think it is the sort of thing that can be solved in a definite way by a massive program. It is going to have to continue over long periods of time.

This will be part of the expanded program at NBS, will be research into this kind of software management.

Senator ROCKEFELLER. Well, how much of this is going on? It is a little depressing to think that—there are lots of bright people in this country and in others, and that this can just go on indefinitely. How serious do any of you think it is at this point in the federal government?

Dr. SMITH. Right now we think the risk is reasonably high, but no serious damage has occurred to date. There are things that can be done to insulate computer systems from outside sources of infection, if you will, to carry the biological analogy, and that is the simplest way to solve the problem, in other words, if you simply do not allow outside software into your system, you can solve the problem.

But in a larger sense, you would like to make your software more robust, more willing to make it immune, if you will, to these kinds of infections. That is the harder question, and that will take significant research and, as I say, a constant battle.

We are well aware of the risk. I think the risk has been reasonably highly publicized now, and there has been some spectacular cases, but as far as definite damage to government systems, we have not been able to see any major problems so far.

Senator ROCKEFELLER. Okay.

Mr. Beringer, Secretary Verity proposes to include the Office of Productivity, Technology and Innovation in any new technology administration.

How would OPTI change if included in such a reorganization, and would it become part of the under secretary's immediate office with major administrative responsibilities, or would you keep it as a separate policy analysis office?

Mr. BERINGER. Of course, the final decisions on that would be left up to the under secretary, so I do not want to try to box somebody in the future into a corner. But it is our present intention that the Office of Technology, OPTI, would be taken in toto into the new organization, and it would perform policy analysis functions as it has in the past.

Senator ROCKEFELLER. My last question to you, Mr. Beringer, and to the panel would be with respect to the Japanese Technical Literature Act.

I think you have got good people and you are trying hard, you got off to a slow start, no question, but you know, that is government, and as I say, you do have good people. I continue to think there is a huge need for this to work. I suspect you have too few people. You probably think you have too few people, too. Budgets from the administration indicate it has gone up somewhat.

How do you assess the contribution of this effort to this point, and where are you satisfied or dissatisfied?

Mr. BERINGER. Before I answer that question, I think I should make one thing clear for the record. University Microfilms, UMI, did not go out of business. It is their Japanese technical literature component that went out of business, and Tom Satoh, who headed that up, is not giving up. He has formed Tom Satoh, Inc. to pursue that.

Senator ROCKEFELLER. Good.

Mr. BERINGER. So I just did not want to cloud the record.

Senator ROCKEFELLER. Maybe the name change will help.

Mr. BERINGER. Right.

I think the report to Congress shows that there is a great deal of effort going on in the field of obtaining Japanese technical literature. As you pointed out earlier, the problem is we think on the receiving end, and we are going to devote more of our resources to making industry aware of what is available. We think that we may not have done a good job in this in the past, and where I think the office is successful is going to all the individual agencies that are listed in the directory and making them aware of their obligation to try to work more closely with the private sector and industry to bring this material that they collect to them.

Right now we are writing to a number of industry associations and asking for their evaluation because, again, it as Dr. Ambler points out, they have to be full partners in this, and we are saying what should we do, what should we do better?

So that is where I think we are making people aware of what is going on, and I think that is our big success.

The Office of Japanese Technical Literature is small, but again, that is only the Office of Japanese Technical Literature. We work closely, for instances, with NBS and NTIA, NTIS, ITA and PTO to bring together a pool of resources, and our total effort I think in the area in

the Department of Commerce is around $2 million to obtain Japanese technical literature.

When taken, the total government effort, I could not even begin to calculate, but for instance, the Office of Naval Research has six people full time over in Japan looking at Japanese scientific developments, and that is why we cosponsored a seminar with them recently on what they found out in Japan on technical developments and bringing it over here.

What we would like to do is bring those scientists, NSF scientists, a Department of Energy Scientist to seminars over here, with the industry folks. Again, that is another approach which skips the time consuming translation and dissemination part. We are going to try that approach also, a direct technology transfer, one on one, as Dr. Ambler's group does so well.

So there are so many approaches and trying to do this, we are still in the assessment stage, but I think we have made a great deal of progress.

Senator ROCKEFELLER. I thank all three of you gentlemen very much for coming here this morning and for the good work that you are doing.

Thank you very much.

Mr. BERINGER. Thank you, Mr. Chairman.

Dr. AMBLER. Thank you.

Senator ROCKEFELLER. The last panel will be Dr. William Howard, Senior Fellow, National Academy of Engineering; Dr. Gregory Eyring, who is a Project Director, Office of Technology Assessment; and Dr. Harold Shill, the Evansdale Library, and Associate Professor at West Virginia University.

I am delighted you are here.

Dr. Howard, perhaps you would like to start off, sir.

STATEMENT OF DR. WILLIAM G. HOWARD, JR., SENIOR FELLOW, NATIONAL ACADEMY OF ENGINEERING

Dr. HOWARD. Good morning, and thank you, Mr. Chairman.

I am delighted for the chance to be here today to discuss the recent report of the National Academy of Engineering Committee on Technology Competitiveness entitled "The Technological Dimensions of International Competitiveness.'

Parenthetically, there are copies—I have left some copies on the table behind me for those that are interested.

This report is the result of more than a year's study of the changing environment faced by the United States in international commercial competition and the role that technology can play in improving our rate of success. As a representative of the Academy and a member of the working committee that performed the study, I would like to briefly describe the recommendations that we have made, particularly as they apply to industry, our governments, both Federal and state, and universities.

In addition, I would like to mention our concerns regarding the development of the kind of work force we must have in this country to compete effectively in the technologically intense world of the future.

The Technological Dimensions of International Competitiveness Study was undertaken by the academy as a part of its own technology agenda program which addresses technology issues affecting the United States world position. The committee which undertook the study and formulated the report was a diverse one. It consisted of 20 members, 12 from industry, seven from universities and one from government. All the members of the committee were elected members of the National Academy of Engineering and were at the CEO or senior policy level of their respective organizations.

Throughout the course of its effort, the committee was impressed by the degree to which the world competitive environment has changed and the rate at which it is continuing to evolve. Twenty years ago we lived in a world in which business as usual attitudes sufficed to enable many individual U.S. firms to compete effectively in the world's largest domestic market, thereby ensuring world leadership.

Now we see a world where continuous improvement of all aspects of our commercial life must become the standard of performance. Success can only be measured on a world market share scale, and global leadership can no longer be assured by premier performance in a single geographic market place.

Increasingly we find individual U.S. firms facing other countries' national enterprises, various combinations of government and private industry in markets at home as well as abroad.

Technology has increasingly been an enabler of commercial success, not just in the traditional high tech fields, but throughout both goods and services industries. The technological dimensions study encompassed both manufacturing based industries and service industries, keeping in mind that many services businesses such as software, communications, transportation, banking and finance, distribution and equipment maintenance are major factors in our national competitive strength, as are manufacturing based businesses.

The report recognizes that private industry, both in the goods and services sectors, is a prime mover in achieving international competitiveness. Many of the improvements already made by leading U.S. companies in upgrading their manufacturing capabilities and product quality are important steps in the right direction. The study also found, however, that the requirements of international competitiveness extend beyond the manufacturing floor to all aspects of the product realization process. Product realization is the collection of all activities that result in a product being brought to market, R&D: product design, fabrication process development, product improvement manufacturing and field support.

World leadership requires that every step in the process must be carried out by competent, motivated people with the same excellence and attention that we are now beginning to expect of world class manufacturing operations.

Now let me turn to agreement. Although industry plays the primary role in responding to the global competitive challenge, governments, both state and federal, take actions which establish important aspects of the competitive environment through a variety of tax, antitrust, trade, fiscal and monetary policies, regulatory actions and so on. In addition, the government provides important support in the form of research and development and infrastructure.

In spite of all this government involvement, the committee noted a distinct lack of a national strategy for harnessing our technological strength to ensure the economic national security of the United States. Furthermore, coherent, consistent mechanisms to formulate regulatory policies to ensure health, safety and welfare of our citizens while maintaining the vigorous economic growth and industrial health on which our economic security depends, are missing.

The dynamic nature of economic, political and technological developments requires that Federal policies be consistently reviewed and adapted to be sure that they achieve the desired social, political and national security purposes but also support or at the least do not impair our international competitiveness.

The Federal Government has been a major supporter of U.S. research and development. It is the major source of basic research funds for universities as well as government laboratories but has been reluctant to become involved in the development of downstream technology unless it is likely to be the principal purchaser of the output.

There are few exceptions. Agriculture and clinical medicine are the most notable.

During the past several years, however, the historic role of government in R&D has been changing as the government-industry-university relationships evolve in response to the need to make more effective use of our national technical resources. Government has become a major promoter of closer university-industry working relationships through programs such as the NSF's Engineering Research Center program. In addition, the federal laboratories have been encouraged to transfer more of their technology to industrial users.

Recent federal participation in the development of technology downstream from basic research has been considered only after a case has been made that a crisis exists, as when the semiconductor or machine tool industry is in danger of irreparable damage from overseas competition.

The federal response has frequently been to turn to the Department of Defense rather than a civilian agency such as the Department of Commerce to act as the federal focus for justification and funding, even though the civilian sector may be the intended immediate beneficiary.

The committee embraced a position contrary to this conventional wisdom. The commonly held view that government should act to support the country's science base but not become involved in downstream technology is based on the concept that the action of the free market is the best incentive for firms to succeed. Unsuccessful

companies are replaced by successful ones, and the country as a whole benefits as stronger domestic firms replace weaker ones.

In today's global competition, however, contests between individual U.S. firms and vertically integrated foreign enterprises can result in the loss not only of American jobs and income but of national technological leadership that can be very difficult to recover in rapidly changing technical areas.

Furthermore, weakness in the critical support of industries such as semiconductors can deplete U.S. capability to compete in other larger businesses, dependent business such as electronics and computers.

In ensuring that the broad national needs of the country are satisfied, the Federal Government, in cooperation with industry, must concern itself with technological opportunities which transcend a single company or industry, or of such a nature that benefits cannot be captured by the firm making the investment, it must therefore be considered as the public good, or which have social or economic impact on large segments of the U.S. population.

A fresh assessment of possible responses by the government in such cases may go well beyond the support of basic research. For the government to participate more actively in R&D directed at enhancing the health of the commercial sector,, it must be prepared both by its intent and its processes, to be more supportive of programs important to technology with commercial potential while relying on the market place to identify products and services to be offered domestically and for export.

The government must be capable of a more complete, systematic analysis of industry capabilities to enable its efforts to underpin the nation's industrial strength without simply replacing industrial efforts. Economic security must also be recognized as a national policy imperative, and the Federal Government must be continuously aware of the national importance of a commercially competitive industry. We can no longer afford simply to respond to crises with military security as the principal rationale.

In support of these, our report lists a number of nontraditional activities the government must be prepared to address. Each of these actions must be addressed in a comprehensive manner, and includes careful assessments of the costs and impacts, with a willingness to look ahead to future circumstances rather than to respond to the crises of the moment.

The committee therefore concluded that two major Federal actions are necessary. First, government and industry must be encouraged to work together to develop a consensus on technology factors that affect both sectors. This requires imaginative leadership both on the part of government and on the part of industry and a lessening of the confrontational environment that exists between them now.

Second, government must rationalize its efforts and focus through a single designated entity in a consistent and logical fashion to encourage and if necessary support technological efforts that are critical to the competitive interests of the nation. This entity should be capable of

responding to industry initiatives and interacting with nongovernmental groups to achieve its ends.

In order to provide the improved information analysis required to manage these activities, the Federal Government should create, with industry support, an activity capable of high quality, in depth analysis of the factors affecting the ability of civilian industries to compete in global markets.

These actions are not intended to replace those activities for which market incentives elicit sufficient private investment or which other arms of government support in fulfilling their own missions. They are intended instead to supplement these technical activities, including sharing costs, in the public interest that otherwise would not be sustainable.

The committee feels that the Federal government should seek to avoid putting itself in the position of unilaterally choosing winners and losers, but should depend instead upon consensus and market action.

The committee considered a number of possible homes for such an activity within the Federal structure but chose not to suggest a specific option. It encourages further discussion so that the responsibility can be assigned promptly and unambiguously.

In rounding out its report, the committee also saw important roles for state governments and universities in enhancing our national commercial competitiveness. Suggestions focus on actions to be taken to strengthen the local industrial base, provide fertile environment for the development of industry, especially small companies, encouragement of joint activities, enhancement of education, dissemination of technological know how.

In the case of universities, the committee further recommended that the impact of support of technology commercialization on their educational activities be evaluated to ensure that their primary educational mission is not compromised.

Finally, the committee was concerned with our ability to develop a work force capable of adapting to technologically induced changes in job content and skills requirements. Our recommendations centered on the educational needs of future workers in an increasingly technical world. Primary, secondary, university and continuing education must all undergo significant development if our workers are to receive a level of education and training equal to or better than the work forces of our strongest competitors. We must offer incentives to encourage our finest undergraduates to continue on to the graduate educational experience, and further, we must see that foreign born engineers that make up such a large portion of our technical graduate school population, have the opportunity to remain in the United States as competitors to our commercial success.

The continuing theme throughout the Technical Dimensions of International Competitiveness Study was the need for continuous improvement in every aspect of our national competitive activity, be it in industry, federal or state government or the educational establishment. We no longer live in a world where business as usual

will suffice or where accepting the status quo is anything but an invitation to failure.

We must be willing to seek innovative ways to meet new technological challenges of the global competitive reality we now face.

Stronger competitors are finding ways to harness technology to success. We must be willing to do the same. We must be able to do the same or risk the consequences.

Thank you, MR. Chairman.

Senator ROCKEFELLER. Thank you, Dr. Howard, for an excellent statement.

I will have some questions for you.

What percentage of the 60 percent of the engineers who get Ph.D.s who are foreign, do in fact stay in this country generally? Do you have any idea?

Dr. HOWARD. We have just completed a report on that. I do not have the number before me, but the number that comes to mind is of the order—it is more than half.

Senator ROCKEFELLER. Is more than half.

Dr. HOWARD. That is my understanding, but I would have to go back and check to be sure.

Senator ROCKEFELLER. I will come back with other questions.

Dr. Eyring, we are looking forward very much to your important statement.

STATEMENT OF DR. GREGORY EYRING, PROJECT DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT, UNITED STATES CONGRESS

Dr. EYRING. Thank you, Mr. Chairman.

Thank you for the opportunity to testify today on OTA's recent work on advanced materials and thank you especially for you continuing interest in this important are.

At the joint request of this committee and the House Committee on Science, Space and Technology, we undertook an assessment of new ceramic and composite materials in June of 1985. In September 1986 we delivered a technical memorandum to this committee, and that work has now been completed. The title of the completed assessment is Advanced Materials by Design. It is currently in the publication process and should be available next month.

Advanced materials will be an important factor in the global competitiveness of U.S. manufacturing industries in the 1990s and beyond. Most analysts have predicted dramatic growth in the markets for these materials in the next 15 years. However, recent experience suggests that most projections of the commercial markets were too optimistic. The costs of advanced materials remains significantly higher than the materials they would replace, and rapid, low cost manufacturing methods have yet to be developed.

In spite of the very promising long term potential of advanced materials the near term investment risks for U.S. companies are high, and those companies that have made the investment have been struggling. In the United States, these technologies are blocked at the level of the commercial end user by two factors: first, the very high capital investment requirements, and second, the very high uncertainties in the markets.

Therefore, beyond military programs there is very little market pull on these technologies in the United States at present.

In contrast, companies in several foreign competitor countries, especially Japan, have initiated more aggressive programs to commercialize their evolving materials technologies. These companies are betting that the experience gained by incorporating these materials in current products will put them in a strong position for the future, even though such production is not cost effective at present. This strategy involves obvious risks, but if the large future markets do develop, OTA finds that this manufacturing is likely to give these companies a significant competitive advantage.

The U.S. government currently spends more than any other nation for R&D on structural ceramics and composites. About 60 percent of the total federal effort is through the DOD, and about 40 percent is through civilian agencies. Compared to DOD and DOE programs, the National Bureau of Standards' programs are quite small, only about 3 percent of the total federal effort.

However, the development of standard, whether for control of the manufacturing processes or for testing of the finished product will be essential for assuring the high quality of materials and structures and for helping to bring their costs down.

Development of international standards for these materials will also facilitate trade and expand markets abroad, and the National Bureau of Standards continues to play a unique and vital role in both of these areas.

This committee explicitly asked OTA to consider how federal R&D investments in national laboratories and universities could be used more effectively to enhance U.S. industrial competitiveness in advanced materials. In addressing this question, we chose to focus on collaborative R&D programs, those based at federal laboratories or universities and having industry participants.

Such collaborations are often touted as an effective way to promote the transfer of federally funded research into commercial products.

OTA's results indicate that such collaborative programs should not be viewed as engines of commercialization and jobs but rather as a form of infrastructure support, providing industry with access to new ideas and trained personnel. Although such contributions are essential and should be encouraged, it appears that a significant gap still remains between the point at which current collaborative R&D leaves off and the point at which industry is willing to make significant investments to commercialize that R&D. Overwhelmingly, the industrial respondents interviewed by OTA did not feel that changes in the institutional

arrangements of these collaborative programs would make any difference. Rather, they felt that the critical problem lies within the companies themselves, that is, how they can justify major investments in R&D in light of the uncertain market environment.

This highlights the fact that effective commercialization of collaborative R&D requires not only a smooth path for technology transfer, but also strong economic incentives within the companies to develop the technology. This point is worth emphasizing because so much of the debate today focuses on the process of technology transfer and ignores the more important factor, which is the market incentives that would drive that transfer.

The primary responsibility for commercialization clearly rests with U.S. industry. However, there is a major need for rapid, low cost manufacturing methods, and most companies simply cannot afford to develop these methods on their own. One option for bridging this gap would be for the Federal and/or state Governments to share these costs with industry by supporting collaborative programs designed to develop these manufacturing methods. The cost sharing could be accomplished directly through Federal matching funds, or indirectly through tax incentives designed to help companies collaborate with one another.

Thank you, Mr. Chairman. I will be happy to answer any questions.

[The statement follows:]

STATEMENT OF GREGORY EYRING, PROJECT DIRECTOR, ENERGY AND MATERIALS PROGRAM, OFFICE OF TECHNOLOGY ASSESSMENT

Mr. Chairman: Thank you for the opportunity to testify at this authorization hearing on the technology programs of the Department of Commerce. The Committee on Commerce, Science, and Transportation has had a long-standing concern about the implications of new technologies for the competitiveness of U.S. manufacturing industries, and especially in how technologies developed in our Federal laboratories can be used more effectively by U.S. industry. In particular, I would like to thank you, Mr. Chairman, for your continuing interest in OTA's work on advanced materials, which will be the subject of my testimony today.

At the joint request of this Committee and the House Committee on Science, Space, and Technology, OTA has undertaken an assessment of new structural materials technologies. In September 1986, OTA delivered an interim Technical Memorandum on the subject entitled New Structural Materials Technologies: Opportunities for the Use of Advanced Ceramics and Composites The complete assessment, entitled Advanced Materials by Design, is currently in the publication process, and should be available in June. This report is highly relevant to the subject of this hearing, since the National Bureau of Standards continues to play an important role in moving these technologies forward.

In the past 18 months, the discovery of high-temperature superconductors has thrust this field into the spotlight of international attention.[1] As exciting as this discovery is, however, it is only one of many extraordinary advances being made across the entire field of materials science and engineering.

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[1] As part of an ongoing assessment of recent breakthroughs in high temperature superconductivity requested by this committee and three other committees of the House and Senate, OTA will release a Special Report on the subject in June prepared by its Industry, Technology, and Employment Program (John Alic, Project Director).

Today, we are learning to use structural materials in an entirely new way. We are no longer limited by the properties of standard steel and aluminum alloys. Not only have we developed new materials, such as ceramics and polymers, with novel and often superior properties; we are learning to combine these materials together into composites whose properties can be tailored specifically for a given application. The advent of such designed materials, which are often called "advanced," will hasten the restructuring of existing materials industries and change the way many goods are designed and manufactured.

Advanced materials will also become an important factor in the global competitiveness of U.S. manufacturing industries in the 1990s and beyond. Today, for instance, materials account for as much as 30 to 50 percent of the costs of most manufactured products. Advanced materials that can reduce overall production costs and improve performance can provide a competitive edge in many products, including aircraft, automobiles, industrial machinery, and sporting goods.

THE U.S. ADVANCED MATERIALS ENVIRONMENT

Most analysts have predicted dramatic growth in the markets for advanced materials in the next 15 years. The value of components produced from advanced materials in the United States has been projected to grow from about $2 billion in 1988 to nearly $20 billion by the year 2000. This estimate includes only the value of the materials and structures; it does not include the value of the finished products (e.g., aircraft and automobiles), whose performance, and therefore competitive posture, would be improved by use of the materials.

However, the experience of recent years suggests that early projections of the penetration of advanced materials into commercial markets were too optimistic. The costs of advanced materials remain significantly higher than the materials they would replace, and rapid, low-cost manufacturing methods have yet to be developed. Until these problems are resolved, growth in the use of advanced materials will be limited to those applications (e.g. military systems) in which the primary purchase criterion is high performance, rather than low cost.

In spite of the very promising long-term potential of advanced materials, the near-term investment risks for U.S. companies are high, and those companies that have made the investment have been struggling. The United States has a thriving community of advanced materials suppliers, often supported by military contracts, and these companies are looking for commercial applications for their materials. However, potential U.S. commercial end users believe (correctly, in OTA's view) that major use of these materials will not be profitable within the next 5 years, the typical planning horizon of most firms. In the United States, these technologies are blocked at the level of the commercial end user by the combination of very high capital investment requirements and a highly uncertain market environment. Thus, beyond military programs, there is very little market pull on these technologies in the United States.

In contrast to the market pull orientation of their U.S. counterparts, end user companies in several foreign competitor countries, especially in Japan, have initiated more aggressive programs to commercialize their evolving materials technologies. These companies are betting that the experience gained by incorporating advanced materials in current products will put them in a strong position for the future, even though such production is not cost-effective at present. This strategy involves obvious risks, but if the large future markets develop as anticipated (or if unforeseen market opportunities arise), OTA finds that this manufacturing experience is likely to give these companies a significant competitive advantage.

Whereas economic and technical uncertainties have been a major obstacle to investment in commercial applications of advanced structural materials, this is even more true of the recently discovered high temperature superconductors. Each week, new breakthroughs are being announced, and promising theories are being disproved. The field is moving so rapidly that firms investing now risk premature commitment to an obsolete technology.

After about a year of policy debate, a broad spectrum of Japanese firms, in cooperation with their Government, appear to be moving ahead aggressively with both basic and applied research on high temperature superconductors, while the U.S. response appears to be more fragmented and cautious. Thus, the same competitive situation that

has evolved between U.S. and Japanese firms in structural materials technologies appears poised to repeat itself in the case of high temperature superconductors. As markets for the high temperature superconductors begin to develop, the early advantage is likely to go to those firms with the greater experience in manufacturing with the materials.

The point is not that there is a "race" to commercialize superconductors, with all of the spoils going to the winner; rather, it is that manufacturing experience over time with these materials is likely to be necessary to compete. U.S. firms should not expect to just step in and produce competitive products after the manufacturing problems have been solved by others.

THE FEDERAL ROLE IN ADVANCED MATERIALS DEVELOPMENT

The Federal Government directly affects the development of advanced materials through funding of basic research, technology demonstration programs, and military and aerospace procurement of advanced materials and structures. The U.S. Government currently spends about $167 million per year for R&D on structural ceramics and composites, more than any other nation. Counting only basic and early applied research, the Department of Defense (DoD) sponsors about 60 percent ($98 million) of this total.

About 40 percent ($69 million) of Federal spending for structural ceramics and composites R&D is nonmilitary in nature, including most of that funded by the Department of Energy (DOE), the National Aeronautics and Space Administration, the National Science Foundation, the National Bureau of Standards, and the Bureau of Mines. These agencies generally do not act as procurers of hardware. Rather, they sponsor materials research ranging from basic science to technology demonstration programs, according to their various mission objectives. Where appropriate, they openly seek to transfer materials technology to the private sector.

Compared to DoD and DOE programs, the National Bureau of Standards' advanced materials R&D programs are quite small, about 3 percent of the total Federal effort. However, the development of standards, whether for control of the manufacturing process or for testing of the finished product, will be essential for assuring the high quality of advanced materials and structures, and for helping to bring their costs down. Development of international standards for these materials will also facilitate trade and expand markets abroad. The National Bureau of Standards continues to play a unique and vital role in both of these critical areas.

THE FEDERAL R&D INVESTMENT AND U.S. INDUSTRIAL COMPETITIVENESS

Recently, there has been a growing concern that Federal R&D investments in universities and Federal laboratories could be used more effectively to enhance U.S. industrial competitiveness. This committee explicitly asked OTA to consider how this could be done in the context of advanced materials. In addressing this question, OTA chose to focus on one important mechanism of technology transfer, the collaboration of Government, university, and industry partners in advanced materials R&D centers.

In the past 5 years, numerous collaborative R&D programs involving combinations of Government, university, and industry participants have been initiated. Some, such as NSF's Engineering Research Centers, have achieved a high visibility. Such collaborative efforts offer a number of potential contributions to U.S. industrial competitiveness, including an excellent environment for training students, an opportunity for each stakeholder to leverage his R&D investment, and research results that could lead to new commercial products.

The high cost of advanced materials development and the small near-term markets are forcing more and more U.S. companies to seek collaborative R&D arrangements in order to spread the risks and raise the large amounts of capital required. Most current advanced materials collaborations are based at universities or national laboratories. These collaborations are often touted as an effective way to promote the transfer of Federally-funded research into commercial products. OTA's results indicate that, while such collaborations do offer important benefits to U.S. industrial competitiveness, commercialization is not one of them.

OTA conducted a survey of 19 Government/industry and university/industry collaborative research programs in order to better understand their role in promoting the competitiveness of U.S. industry. OTA found that neither the programs' staffs nor their industrial participants rank commercialization of research results high on their lists of priorities; furthermore, neither party systematically tracks commercial outcomes. Many of the university-based programs concentrate on publishable research and graduate training, while those programs based in Federal facilities are only now beginning to move away from their primary agency missions toward a broader concern with U.S. industrial competitiveness.

According to the OTA sampling, the programs' industrial participants often have only a modest amount of involvement in the planning and operation of the collaborative programs. By and large, the industrial participants value their access to skilled research personnel and graduate students more highly than the actual research results generated by the collaboration. Furthermore, "collaboration" may be an inaccurate description of the programs studied. In large measure, the programs do not involve intense, bench-level interaction between institutional and industrial scientists; rather, the nature of the collaboration seemed to be mostly symbolic.

There are exceptions to these general observations in some of the newer programs in university-based consortia and quasi-independent R&D organizations that conduct both generic and proprietary research in parallel within the same program. Often undertaken in conjunction with State (rather than Federal) Government funding, these organizations incorporate a greater commitment to commercialization and economic development in their mission. This suggests that if commercialization is in fact one of the goals of collaboration, it needs to be a much more organic part of research-performing organizations than merely an added-on element.

For the products of collaborative research to be commercialized, there must be a corresponding capacity and willingness on the part of the industrial participants to do so. However, only about 50 percent of the advanced materials company participants interviewed by OTA reported any follow-on work stimulated by the collaboration. This strongly suggests that such collaborative programs should not be viewed as engines of commercialization and jobs, but rather as a form of "infrastructure support", providing industry with access to new ideas and trained personnel.

Overwhelmingly, OTA's industrial respondents did not feel that changes in institutional arrangements with research performing programs would be an important lever in facilitating the commercialization process. Rather, they perceived that the critical issue revolves around the economic problem described above: how companies, particularly in the advanced materials area, can justify the cost of major investments in R&D and new manufacturing facilities in light of uncertain markets.

This highlights the fact that effective commercialization of collaborative R&D requires not only a smooth path for technology transfer from the R&D center to its industrial participants, but also strong economic incentives within the companies to develop the technology This point is worth emphasizing, because so much of the debate today focuses on the process of technology transfer, and ignores the more important factor, which is the lack of market incentives that would drive this transfer.

In summary, there is evidence that existing university/industry and Federal laboratory/industry joint R&D centers in advanced materials do not address the problem of commercialization of research results very effectively. Rather, these programs tend to be seen by industry as promoting the infrastructure of the technology; i.e., providing access to new ideas and trained students. Although such contributions are essential and should be encouraged, it appears that a significant gap still remains between the point at which current collaborative materials R&D leaves off and the point at which industry is prepared to make significant investments to bring this R&D to commercial fruition.

The primary responsibility for commercialization of advanced materials technology clearly rests with U.S. industry. However, given the nature of the risks posed by manufacturing with advanced materials .. very high scale-up and production costs in an uncertain market environment .. the necessary investment in commercialization is not being made by U.S companies. One option for overcoming this barrier would be for the Federal (and State) Government to share these costs by supporting collaborative programs designed to develop more cost-effective manufacturing methods. The cost shar-

ing could be accomplished directly through Federal matching funds, or indirectly through tax credits designed to stimulate cooperative research. These programs would not require the building of new facilities; rather, they could be based at existing centers of excellence.

There are several characteristics that such collaborative manufacturing centers should have if they are to be successful in promoting technology utilization by industry. First, the centers should incorporate the commercialization perspective into the fabric of their structure from the beginning. They should be located in settings that are very conducive to the intermingling of industry and research staff concerns. Industry should be directly involved in the planning, funding, and administration. The centers should feature direct, bench-level collaboration between visiting industrial scientists and the facility research staff. Industry managers, production engineers, and marketing personnel should have temporary assignments to work with the center staff to develop the manufacturing infrastructure needed. The centers should have ample opportunities for proprietary projects to be carried out for individual industry clients in parallel with the broader program of widely disseminated nonproprietary projects. Finally, the industry participants should commit sufficient resources to their own internal R&D efforts to be able to employ effectively the research output of the centers.

Thank you, Mr. Chairman. I will be happy to answer any questions.

Senator ROCKEFELLER. Thank you very much, Dr. Eyring, and I have some for you.

Dr. SHILL. I am obviously very pleased not only that you are here, but that we have a chance to correspond so much and that you are so good.

STATEMENT OF DR. HAROLD B. SHILL, HEAD LIBRARIAN, EVANSDALE LIBRARY, WEST VIRGINIA UNIVERSITY

Dr. SHILL. Thank you very much, Mr. Chairman, for your kind introduction. Maybe I should stop at that. I am not sure I can do any better.

I am Hal Shill, head librarian of the Evansdale Library at West Virginia University, and I would like to spend a few minutes describing our use of NTIS resources and services in the Evansdale Library, the importance of NTIS in the scientific and technical communications system that we have today, and some implications of privatization proposals that have been made and continue to resurface.

The library which I head is the largest branch library at West Virginia University. It holds about 200,000 paper volumes and about 700,000 microfiche, of which about 400,000 are from NTIS and about 300,000 from the ERIC collection. The fields we primarily support are engineering, agriculture, forestry, computer science, education and several other fields. We also have considerable use by our faculty in medicine, especially those who are doing research in biotechnology areas, and we have considerable interaction with our business faculty whose library collections are primarily housed elsewhere on the campus.

We have been very active in our support for economic development in the State of West Virginia, too, in developing collections and services supporting traditional economic efforts, such as improving clean coal combustion through fluidized bed combustion, research, and also in trying to attract some new high tech industries to diversify our economic base as well. We have been cooperative with the Software Valley Enterprise that Senator Byrd has pushed very hard, which I

think you are aware of. We provide access to the NASA/RECON data base in support of economic development.

In the Evansdale Library itself, to just embark on the first of my three prongs, the collection profile includes 33 areas in which NTIS collects various Federal agency, state Government and foreign technical reports. Mainly they are coal and energy related areas. There are a few others as well. We make these accessible to the general public as well as to the university community. We do loan out our microfiche reports. We do have a few reports which we catalogue for access through the card catalogue.

We get a fairly significant amount of use by small firms, who are frequently some of the most innovative in the country in coming up with new ideas, and I think we are a very important point of access to this literature for the small firms. We receive the major index to the NTIS literature, Government Reports Announcements and Index, through the Federal depository library program, and it is very important that we——

Senator ROCKEFELLER. Could I interrupt for a second? When you said that very small industries, in fact, are often very innovative. This is statistically true, and also interesting, is it not, because one tends to associate enormous research teams and large scale labs and all kinds of things with striking innovation.

Why is it that small businesses are able to produce so much technological innovation for us in this country?

Dr. SHILL. Well, in some cases—I am purely speculating in this. I am not an expert in the area, but I suspect they may be free of some organizational baggage that they have in organizations which have done things in very traditional ways. You may occasionally have entrepreneurs who are stifled within a larger corporation who do get out on their own, start a small group, are able to focus in a particular area, and do that.

One of the articles I've read in this area was from one of Commerce's own publications, "Business America," a few years ago. This article indicated that about 50 percent of the major discoveries over the last 30 years have been made by small firms.

Senator ROCKEFELLER. It is true, but it is interesting.

Dr. SHILL. It is very interesting. I would defer to an economist——

Senator ROCKEFELLER. Again, it is a little bit of the Lone Ranger concept, people breaking off, going out on their own.

I am sorry to interrupt you.

Dr. SHILL. Thank you.

Other NTIS services we provide include on-line searching of the NTIS data base, which is the fifth most heavily used of the approximately 350 data bases to which we provide access through the Evansdale Library. One of the interesting ways in which we utilize this data base is to provide current awareness profiles which we call SDI, selective dissemination of information, not Strategic Defense Initiative, and these two are in the areas of robotics and low volume road use. The robotics one in particular is very interesting because the professor

for whom we do that feels he is on the cutting edge of robotics research, and he is sharing the citations and the abstracts with his students as well as keeping aware of what is going on.

So in this case, I think the use for the data base of biweekly listings of new research reports really substitutes for reading the documents themselves, and a great many of those are from foreign countries, from the Netherlands, from Japan, from Italy, from Great Britain and other countries in which robotics research is done.

We also have a very active bibliographic instruction program. We are teaching most of our advanced undergraduate and graduate students to systematically get access to the technical report literature through "Government Reports Announcements and Index;" hopefully down the run, efforts by our library and other similar libraries supporting engineering and related disciplines will lead to an increasing use of the technical literature, which includes both the formal communications system and the technical report literature which we do have.

We also provide access to NTIS order forms for people who want to purchase documents for their own use. We have them sitting in a box right beside "Government Reports Announcements and Index," so we naturally do not show any statistics ourselves on orders by individuals who have used it and purchased things for their own use, but we do provide something of a marketing device ourselves for some of the NTIS services.

In the area of scientific and technical communication today, NTIS, as several of the witnesses have mentioned earlier, provides access to a great deal of the approximately 50 percent of our $125 billion in research and development that is financed by the Federal Government today. There is some concern that not all of the reports are getting into the NTIS data base right now. That figure may be in the area of 50 percent, though the estimates I have seen from NTIS and others who have studied the agency vary a good bit over recent years.

It is very important for providing access to foreign technical literature. Approximately 25 percent of what is added right now is from other countries, which is a substantial increase from years in the past. Much of it is from Japan, some of it translated, much of it in Japanese.

It is a permanent archive for about 2 million reports. While the heaviest use is in the most recent years, we cannot determine for sure that an older report is not going to prove to be very important. One example which came to mind last summer was when there was some concern about possibly using blimps for surveillance in the Persian Gulf area, and I would think that a lot of the dirigible reports are probably not very recent in origin. Prop/fan jets would be another one. There is some interest in the aerospace engineering area in some of the World War II vintage wing designs as well.

So there is a legitimate reason for hanging on to the old reports in an archival capacity.

The central indexing that is provided by "Government Reports, Announcements and Index" is crucial to knowing what research actually has been done in the past. This is something that you do not get by

just announcements of what has been most recently added. People do want to do retrospective research in these areas, and that is what is provided by "Government Reports, Announcements and Index." Many of the people in the library and scientific communities have been supportive of NTIS, have been very positive about its one-stop source feature that rather than going around and hunting among 350 odd different Federal agencies, they are able to communicate with one agency and get access to a great deal of the technical report literature.

Another advantage has been the relatively low cost of it, although those costs have increased in recent years.

I know you are under time constraints now, so I will move on to the privatization implications of those proposals. In the early 1980s, four different NTIS functions were reviewed for privatization under OMB Circular A-76, and it was found that each of them could be performed more inexpensively in-house, so that was abandoned. And more recently, OMB has followed the fed co-op proposal and some other initiatives to pursue privatization.

I am concerned about this for a number of reasons. One, I have a concern about the willingness of many of the Federal agencies to deposit their reports with a private vendor. If they do not do this, this then impairs researcher access to this literature, and in the long run, our research productivity.

There is a concern about the willingness of foreign Governments to deal directly with a private vendor. We have some concern about the possibly adverse operation of some market factors in this area, perhaps a private vendor might choose to emphasize dissemination of the hot items. Perhaps we might require additional personnel in Commerce to perform oversight activities.

We would be concerned if the vendor were going under, and JTIS did so recently. What would vendor performance be under that circumstance? I think that is a legitimate concern.

There have been some concerns raised about the legality of the transfer. A 1982 CRS report raised some major questions about whether this could be done without specific statutory authorization.

We would have a concern about the monopoly on access to that information that a vendor might have. We have a public policy concern about the possible resale of taxpayer produced information for private profit. We feel that there is something of a loss in investment to the taxpayer there.

We would be concerned about the adverse effect on other Government information dissemination programs as well. As you may know, the Government Printing Office and the Joint Committee on Printing, in collaboration with 16 agencies, have developed some project proposals for electronic dissemination of Government information. Those were put on the shelf by the House Appropriations Committee last year pending the completion of an OTA report on electronic dissemination of information which we are hoping to see very, very soon. But we would have some concern about whether electronic dissemination would be done through conventional channels and through depository libraries.

We would have a concern about the abdication of responsibility for policy setting in this area, if NTIS were privatized. The fed co-op proposal is one which I find very difficult to take seriously, quite frankly. It seems driven by ideological motives. I remember reading OMB's blueprint for fed privatization, and one statement at the end of it was that the people most affected by privatization would be the agency employees. I would beg to dissent very, very strongly from that. The agency is not a jobs agency. It exists to provide a very important service for our research infrastructure.

And then finally, the Department of Commerce itself, in its own internal study of privatization in the fall of 1987 recommended against further privatization. I would just like to bring to a conclusion my testimony by briefly reading from their statement. They have said given the impetus for their study of privatization, the Governmental costs and risks must be of major interest. They clearly include monetary costs, since discontinuing any significant portion of the NTIS program will increase rather than decrease Federal appropriations. Most important, however, are the policy costs and risks, those associated with U.S. competitiveness, national security, technology transfer, intellectual property rights,, and the availability of scientific and technical information.

Thank you very much, Mr. Chairman. I will be glad to answer any questions.

[The statement follows:]

Statement of

Dr. Harold B. Shill
American Library Association
West Virginia University

Mr. Chairman and Subcommittee members, I am Harold Shill, Head Librarian and Associate Professor at the Evansdale Library, West Virginia University. My library serves research, instruction and service programs in Engineering, Agriculture, Forestry, Computer Science, Education and several other academic disciplines. As the largest branch library at my State's land-grant university we also have a statewide mission to share technical information in support of economic development -- one of West Virginia University's five strategic priorities -- and the Agricultural Extension Service.

It is my privilege today to testify on behalf of both West Virginia University and the American Library Association (ALA). West Virginia University, an institution of 17,300 students, is both the comprehensive and land-grant university in the West Virginia system of higher education, and offers 78 master's degrees and 29 doctoral programs. ALA is a nonprofit, educational organization of 45,000 librarians, library users and library supporters devoted to the improvement of library and information services for the entire population. Within ALA, I am currently serving as chairman of both the Association-wide Legislation Assembly and the Legislation Committee of the Association of College and Research Libraries, ALA's largest division. I have also served as Federal Relations Coordinator for the West Virginia Library Association since 1983.

I have been asked to address the current status and future of the National Technical Information Service (NTIS) today. In doing so, I would like to share with the Subcommittee: 1) information about the use of NTIS collections and services in my own and other libraries; 2) my views on the importance of NTIS in existing systems for the communication of scientific and technical information (STI); and 3) some specific concerns about the potential impact of privatization proposals for this agency.

I. NTIS Collections and Service Use in Academic and Research Libraries:

Documents archived, processed and disseminated by NTIS are critical to the national research and development (R&D) effort, whether ordered directly by end users or acquired by libraries in the university, corporate, and governmental research environments. Many university libraries provide permanent access to significant parts of the NTIS document collection. Texas A&M University, for example, has 70 percent of the overall collection in its libraries. At West Virginia University, a 400,000-document NTIS collection has been developed through standing orders in 33 subject categories (see Appendix A) and selective purchases of documents outside our profile. NTIS documents are also often shared among libraries through interlibrary loan networks, an option we have used 17 times between August 1987 and April 1988 to borrow reports outside our collection profile. This recurrent access to NTIS documents through libraries is an important and lasting "value added" through the current distribution system.

In addition to archiving much of the NTIS collection, university libraries also promote use of NTIS documents in a variety of ways. At West Virginia University, instruction in the use of GRA&I, Government Reports Announcements and Index, the primary index for identifying NTIS documents, is given in all of our bibliographic instruction classes for graduate and advanced undergraduate engineering students. It is expected that these individuals will then use NTIS resources both in their academic work and later in their working careers. Searches of the online NTIS database are also encouraged for all grant-funded and dissertation/thesis research, and the online version is the fifth most heavily used of the 350 plus databases accessed at WVU. Use would be even higher if DIALOG, the private vendor through which we use the NTIS database, had not increased its online connect-hour charge from $45 to $69 per hour in the past few years. SDI (selective dissemination of information) profiles on robotics and low-volume road maintenance are also maintained for two engineering faculty members. These researchers receive biweekly printouts of new reports added to the NTIS database in biweekly updates. As a result, they and their students are kept abreast of the state-of-the-art in these areas, since research reports are usually well ahead of the published journal literature in currency.

NTIS products are also a mainstay of corporate and governmental research library services. For example, at the Westinghouse Research and Development Center Library in Monroeville, Pa., $7200 worth of NTIS documents were purchased to support diverse Westinghouse research projects in the first five months of 1987 alone. The privatized Morgantown Energy Technology Center Library has bought $5000-$6000 worth of NTIS documents annually since 1980. The Appalachian Laboratory for Occupational Safety and Health Library, also privatized, has purchased an average of 360 NTIS documents annually for the past five years. Librarians in all three of these facilities are extremely pleased with current NTIS services and concerned about possible cost increases, permanent availability of documents, and loss of the "one-stop source" feature should NTIS be privatized or otherwise dispersed among several organizations.

The Research Environment:

The environment in which American R&D are performed has changed radically since World War II. Prior to that conflict, research was performed primarily in the industrial sector and by university-based investigators. The federal government first assumed a major role in this area during World War II by supporting research with potential military applications. In addition to profoundly changing university-government relationships, the wartime research effort also established the Federal Government as a major research sponsor and created a body of technical reports potentially useful for both applied and basic research (Osburn, 1979, pp. 4-38). That literature was preserved and made available for repeated societal use by the Publications Board and the Office of Technical Services.

Research in both the private and public sectors has thrived since World War II, and much of that success is attibutable to continued federal government support for basic and applied research and the ready availability of documents communication the results of that research. The National Science Foundation (NSF) has estimated that $118.6 billion was spent on R&D in 1986 (Statistical Abstract of the United States,1987, p. 564). 50.1 percent of R&D funding was provided by industry, 46.5 percent by the federal government, 2 percent by universities, and 1.4 percent by other sources. However, 73 percent of that research was performed by industry, 12 percent by Federal agencies, 9 percent by universities, 3 percent by Federal R&D centers, and 3 percent by "other" organizations (ibid, p.564). These figures are very different from those for 1960, when only $13.5 billion was spent on R&D and 65 percent of that amount came from Federal sources. The shift toward private sector domination of R&D funding is particularly significant, since most research in the industrial sector is proprietary in nature and generally is not available to the general public or to other firms.

There have been some other important changes in the American research infrastructure as well. For one, 50 percent of all major innovations in the last 30 years have come from small firms rather than large corporations ("High-Tech Services for Small Business", 1986, pp. 2-7). University-industry partnerships and giant research consortia also have become increasingly important as federal research patronage has dwindled in recent years and the need for corporate collaboration to meet foreign competition has become apparent.

A final -- and crucial -- factor affecting the R&D environment is the vast increase in significant scientific and technical research done in other countries since the end of World War II. Wartime devastation left Britain, France, Japan, Germany and other countries economically shattered in the late 1940s, and the United States stepped into artificial dominance of sci/tech Research. In recent years, however, it has become apparent that advanced countries have equaled or surpassed American research productivity in several areas, most notable some in high technology. Japan, for example, had already exceeded U.S. national spending on both Engineering and Medical Research as early as 1981 (National Science Board, 1984, p. 206). Growing awareness of the importance to American research of foreign STI led to the 1986 passage of the Japanese Technical Literature Act, thereby establishing within the Commerce Department a program for coordinating U.S. access to Japanese STI.

Formal and Informal Communication Systems:

Research spending, no matter how extensive of focussed, may have no impact beyond the project for which funding has been provided unless its results are shared with other investigators having similar interests. Since facilitating access to such results is the fundamental purpose of a clearinghouse, it is useful to examine briefly the formal and informal communications systems of technical research in order to assess the effectiveness of NTIS as a mechanism for information transfer.

Technical information is disseminated in the United States through journals, trade publications, meetings, conference proceedings, exhibitions, and informal contact between individuals with common interests. Indexing and abstracting services, such as Chemical Abstracts and Engineering Index, systematically document research reported through journals and conference proceedings, thereby enabling academic and corporate researchers to readily identify a signifant body of knowledge available for public use. In addition to this formal system of communication, researchers often share information prior to publication through networks, or "invisible colleges," of persons with similar interests. (Crane, 1972). Engineers have been particularly inclined to use informal channels of communication,such as colleagues and supervisors, rather than rely on the formal communication system for new information (Shuchman, 1981).

Information entered into the formal communication system is accessible to anyone who uses an abstracting service and can secure a physical copy of the document from a library collection, through interlibrary loans or by direct purchase of the item. In contrast, much of the knowledge produced through corporate research is considered proprietary. Though it may be disseminated within the organization, the resulting data is generally not shared with academic or government researchers or competitors. Corporate researchers do, however, pay close attention to research results reported through the formal communication systems of scientific and technical disciplines and attend meetings of professional societies to gain first-hand exposure to new ideas. Except for large corporations able to support their own specialized library, institutional and large public libraries are the primary point of access to knowledge conveyed through the formal communication system.

New technologies and structural changes in the information sector are significantly altering the formal communication systems which have supported academic, governmental, and private sector research. Most major indexing and abstracting services are now available in both print and machine-readable form. In addition, many new databases with no print equivalents are now available online from database vendors. These databases are usually searched either by librarians or by corporate information specialists with search language training, although direct searching by information end-users is growing. In all, more than 3700 databases developed by 1685 producers are now available online though 355 separate online services (Cuadra, 1988, p.3).

Individual use of new technologies is altering the informal communication systems of science and technology as well. The telephone,photocopier and word processor have permitted immediate verbal contact and greatly enhanced individual research productivity. Personal computers, when linked to telecommunications capabilities, have enabled researchers to send electronic mail messages to each other and to directly access databases in the formal communication system. Computer conferencing has permitted individuals in geographically separated locations to work collaboratively on a research problem or a manuscript. Additional enhancements are likely as researchers become aware of, and utilize more fully, the assets of a decentralized, electronic information environment.

A second significant development has been the trend toward concentration in the publishing industry. Private vendors have taken over many journals formerly published by professional societies. These publishers usually charge a significantly higher subscription rate to institutional subscribers, including libraries. There has also been a trend toward takeover of established library vendors, such as the R.R. Bowker Co. and Gale Research Co., by large conglomerates. Although it is premature to judge the long-term effects of that tendency, there is considerable concern in the library community this monopolistic practices may be encountered in the future. Since many important STI publishers are foreign-owned, libraries and individual subscribers have faced sharp price increases with the decline of the dollar in the mid-1980s. As a result, many research libraries have had to cancel numerous journal subscriptions, thereby reducing access to the formal communication system for university, private sector and government patrons. My own library system has had to cancel 726 of its 9600 journal subscriptions this year, so cost is becoming an increasingly pivotal factor influencing libraries' ability to support information transfer.

A third important development in the past several years has been the inauguration of electronic publishing. All 16 journals published by the American Chemical Society are now available in both print and electronic full-text format. Assessing the long-term direction of this trend, F. Wilfrid Lancaster has predicted that 50 percent of all indexes and abstracting services will be available only in electronic form by the year 2000. Lancaster has also hypothesized that 50 percent of all technical reports will be disseminated only in machine-readable form by the turn of the century. He has further predicted that the shift away from the "print on paper" format will occur first in the STI area (Lancaster, 1982, p.61).

It is apparent that the era of formal communication primarily through the print media is coming to an end. Since information stored in computers is normally provided on a cost-per-use basis, it is also clear that access to indexing and abstracting services and to many documents themselves is coming to depend increasingly on one's ability to pay. This move toward fee-based services could considerable alter the economics of technical communication by skewing the system in favor of large firms and well-funded academic researchers at the expense of innovative smaller firms and individuals.

NTIS and the STI Infrastructure:

NTIS occupies a unique role within the technical information infrastructure. As a clearinghouse, it provides access to approximately 2 million reports of completed, government-sponsored research and disseminates these documents through libraries and an active sales program.

More than 70,000 new reports are added annually, 25 percent of them from foreign governments. Reports are submitted by more than 350 Federal agencies, and deposit agreements have been arranged with the Department of Energy, Department of Defense, Environmental Protection Agency, and National Aeronautics and Space Agency (NASA). Some reports from corporations, state governments and non-governmental research facilities are also included. However, it is still possible that more than 50 percent of technical reports sponsored by Federal agencies are not available through, or documented by, the clearinghouse. Most of the reports it acquires from other Federal agencies and foreign governments would quite simply not be accessible to researchers if NTIS or a similar organization did not exist.

NTIS sales data for FY 1984 totalled $20,695,431. 33 percent of those sales were to U.S. business and industry, 20 percent to foreign business and industry, 17 percent to individual purchasers, 16 percent universities, and 14 percent to Federal and state government agencies (McClure, Hernon and Purcell, 1986, pp. 36, 43). Each of those categories, except the individual purchases, includes numerous titles added to library collections for repeated local use.

As an organization, NTIS has been recognized for its effectiveness through receipt of the 1987 Virginia Productivity Award. However, it is not clear whether the agency, despite being well-run, has had the influence on American research productivity which might be desired from a central STI clearinghouse. It has clearly not had the impact of the Japan Information Center of Science and Technology (JICST), though that result may be partly due to the ethnocentrism of American researchers (Ballard, 1987, p. 220). It has, however, provided systematic, central, reliable access, over a 40-year period of rapid technological change, to a wide body of non-classified research relevant for industrial and military applications. That body of research can be identified systematically through GRA&I and the online NTIS database. The prevailing consensus in the scientific, technical, industrial and library communities is that NTIS has served the research enterprise well.

The NTIS Privatization Push:

Four NTIS functions - subscriptions, input procesing, information analysis and order fulfillment - were reviewed for possible privatization in the early 1980s and mid-1980s under OMB Circular A-76. Bids by private contractors were all rejected in the each instance because cost comparisons showed that the function could be performed more inexpensively in-house (Hearing on the Privatization of the National Technical Information Service, 1987, pp. 20-21). Use of the A-76 approach to NTIS privatization was apparently abandoned by Office of Management and Budget (OMB) after the contractor's low bid for order fulfillment was found in March 1985 to be $656,854 greater than continued operation by the agency (ibid, p. 20).

The real push to privatize NTIS began late in 1985, at the same time that OMB Circular A-130 was being formulated at OMB. NTIS, it was contended by supporters of privatization, was engaged in "unfair competition" with the private sector. It was further argued that a private firm, operating under market incentives, could more effectively bring relevant literature in the NTIS collection to the attention of researchers needing that information.

An announcement in the April 28, 1986, Federal Register launched the formal effort to contract out the agency's operations to the private sector. That notice solicited public comment on various alternatives for privatizing the agency. The initial, 45-day comment period was extended to permit responses by the wide range of organizations and individuals expressing interest. Of the first 138 letters received in response to the notice, 122 were clearly opposed to privatization of the agency. Letters opposing the initiative were received from 41 universities and colleges, 14 scientific and professional societies, 13 Federal Government agencies and research laboratories, 10 corporations and private businesses, 6 medical facilities and libraries, 6 private citizens, 5 state libraries, 5 public libraries and 2 Members of Congress. Letters of opposition were received from 32 states and the District of Columbia by late June 1986 (NTIS Privatization Study Responses, 1986).

Despite this strong expression of opposition across many sectors of American society, the Commerce Department Task Force on NTIS Privatization continued to investigate privatization alternatives. A meeting with potential contractors to review privatization alternatives was held June 16 with only 6 days' public notice. Interested individuals were later invited to attend an informal "workshop" to discuss these alternatives July 30, 1986, in Washington. The NTIS Privatization Workshop agenda was structured to include six topics: providing value-added products and services, contracting out, establishing a dealership arrangement, distribution of electronic information, establishing NTIS as a government corporation, and "special proposals" (GPO-NTIS "super" agency, National Technology Center, etc.). All six topics were to be addressed from the standpoint of their contribution to Administration privatization goals, rather than enhancement of STI flow or the desirability of public or private operation of NTIS. Nevertheless, participant sentiment was again overwhelmingly opposed to privatization as an option per se(Public Workshop to Discuss Alternatives and Issues, . . . 1986). Ideas presented at this workshop, as well as letters elicited by the April 28 Federal Register notice, were conveyed to the Commerce Task Force for further review.

Upon concluding its investigation, the Commerce Task Force recommended against privatization in early 1987. Pursuit of the privatization option, it reasoned, would be undesirable for the following reasons:

> Given a program so complex and so privatized, any decision to make further privatization moves must be supported by evidence of extensive benefit and minimal cost. Such evidence does not exist. In fact, as this (Department of Commerce) report clearly demonstrates, the evidence is that extensive privatization presents substantial costs and risks for the government, for NTIS customers, and for the information industry as a whole.
>
> Given the impetus for the study, the governmental costs and risks must be of major interest. They clearly include monetary costs, since discontinuing any significant portion of the NTIS program will increase rather than decrease Federal appropriations. Most important, however, are the policy costs and risks, those associated with U.S. competitiveness, national security, technology transfer, intellectual property rights, and the availability of scientific and technical information.
>
> (Wood, Testimony of Dr. Fred B. Wood, p. 12)

These arguments notwithstanding, OMB continued to press Commerce to privatize the agency, and the President's FY 1988 budget proposal in January 1987 "assumed" that NTIS would be operated by a private contractor.

Faced with continuing Administration efforts to privatize the agency despite Commerce recommendations to the contrary, the House Science, Research and Technology Subcommittee held hearings on the privatization proposal in March 1987 and on Federal information resources management policy in July 1987. Several pieces of legislation, including a bill to make NTIS into a government corporation (H.R. 2159) and another to create a Government Information Agency (H.R. 1615), were introduced by Rep. Doug Walgren and Rep. George Brown, Jr., respectively. Republican and Democratic Subcommittee members alike expressed displeasure with the lack of a clear STI policy and the NTIS privatization proposal.

Anti-privatization language was written into the National Bureau of Standards Authorization Act (H.R. 2160) on the House side and into the trade bill (H.R. 3, with text of S. 1624) on the Senate side. Since neither bill was considered by the other house during 1987, the respective anti-privatization provisions stood as expressions of Congressional policy preference, but lacked the force of law.

The Administration resumed its initiative early in 1988, announcing in the January 6 Commerce Business Daily that a Request for Information meeting would be held January 29 to investigate contractor interest in privatization of NTIS through an Employee Stock Ownership ("Fed Co-op") plan, something never before attempted with a Federal agency. Although the idea drew mixed reactions from potential vendors, Commerce officials announced that privatization of NTIS was moving on a "fast track," with a request for proposals (RFP) expected to be issued by the end of February. That RFP, it was indicated, would include a 30-45 day response period, making it conceivable that a contract could be let to a potential vendor as early as April 1.

The House Science, Research and Technology subcommittee held hearings February 24 and March 11, 1988, to examine the Fed Co-op proposal and to consider alternatives for Congressional action. Senate and House negotiators then agreed to utilize anti-privatization language in the trade bill (H.R.3) to enact a legal prohibition against large-scale contracting out of NTIS services. Language prohibiting NTIS privatization has also been written into the National Bureau of Standards authorization bill (H.R. 4417) being considered by the House. It is also my understanding that provisions converting the NTIS into a government corporation may be inserted into the NBS authorization bill on the House side should President Reagan veto the trade bill.

Several other developments pertinent to the NTIS privatization debate have occurred this spring. First, the Commission on Privatization delivered its report March 18, 1988. That report did not list NTIS as an agency whose operations should be privatized. Second, Secretary of Commerce C. William Verity expressed his own opposition to the NTIS privatization proposal in late March 1988, thereby leaving OMB as the principal actor in the Administration still actively pursuing the privatization option.

The final outcome of the NTIS privatization conflict is still uncertain as this testimony is being written.

Implications:

The outcome of the NTIS controversy has very major consequences for the STI communication system in the United States, for research, for American competitiveness, and for larger questions of information policy and government information activities.

It has been noted earlier that the United States lacks a coherent national information policy, unlike most other industrialized nations. That lack of a policy has come to be seen increasingly as a national liability by critics in Congress and elsewhere concerned with American research productivity in an increasingly competitive international economic system. At a broad policy level, the outcome of this debate will effectively determine whether the United States opts for 1) a technical information system driven largely by market considerations or for 2) a centralized system based on a clearly-articulated conception of technical information as a resource to be exploited systematically for larger national purposes.

The outcome of the NTIS privatization controversy may also have a significant impact on researcher access to individual reports, whether domestic or foreign in origin. It is clear that agencies would not as willingly deposit their research reports with a private vendor as they do with another governmental unit. There is likewise concern that foreign governments would not be as willing to share their reports with a private organization as they would with another government. Furthermore, from the perspective of STI access, there is a real concern that a private vendor would emphasize the dissemination of "hot" items to the detriment of the remainder of the collection.

In addition to its likely adverse effect on American research, the NTIS privatization proposal raises some troubling legal and policy questions. A 1982 study by the American Law Division of the Congressional Research Service (CRS) concluded that "transfer of these functions to the private sector without additional authorizing legislation would be contrary to the Congressional intent behind Public Law 81-776, and may well conflict with the statutory mandate found at 15 U.S.C. 1152." Letting of a contract to perform NTIS functions to one vendor could also be seen as providing monopolistic access to the information itself for that vendor. Finally, a basic issue of public policy would be raised by the re-sale for private profit of resources developed at taxpayer expense if those same items were not also available from the Federal Government.

The resolution of the NTIS debate will also be an important precedent for other Federal activities in information distribution/dissemination. Should the agency be privatized, it is likely that other information organizations within the Federal Government, including GPO and the three national libraries, will be under increasing pressure to make maximum use of private intermediaries for the dissemination of documents and provision of services. A major impact of such an outcome would likely be a reduction in the use of GPO for printing activities and, as a result, a sharp lowering of the number of publications included in the Depository Library Program (DLP). Since the DLP is the major mechanism for widespread distribution of government information throughout the country, reduced access to governmental data and publications of all types would likely result.

In addition to that long-term effect, a resolution in favor of privatization would also be likely to have a profound effect on future government distribution of information in electronic format. Currently, experimental projects have been proposed by the Joint Committee on Printing, GPO and approximately 16 Federal agencies to distribute government-generated data in electronic format through the DLP. The House Appropriations Committee declined in 1988 to allocate $800,000 from GPO's revolving fund for electronic pilot projects pending submission of a Congressional Office of Technology Assessment (OTA) report on the electronic distribution of government information. The report, which was expected in the fall of 1987, is apparently now nearing completion. Some private vendors are interested in acting as distribution agents for electronic information, which falls into a "gray area" for submission to the DLP under Title 44 of the U.S. Code, and privatization of NTIS would strengthen their claim to a role in this area. The result of such an outcome would clearly be a long-term stratification of government information users on the basis of ability to pay, thereby broadly linking access to financial means, reducing official accountability, and possibly making such information more difficult to locate in the first place.

Clearly, the outcome of the NTIS controversy carries implications well beyond the immediate future of this agency and its employees. Whether recognized as such or not, it is a major decision which will affect the direction of both STI policy and general Federal information activities for years to come. Both users and potential users of government-produced information will be affected in the short run, and the ability of the United States to use technical information as a national resource could be profoundly affected in the long run.

The American Library Association adopted a resolution stating its strong opposition to OMB's NTIS privatization proposal in January 1987. That resolution is attached as Appendix B. As a librarian at West Virginia University, I am gravely concerned that we would not be able to afford the services of a privately-owned NTIS and that our research mission and support for economic development would suffer as a result. I commend both Houses of Congress for their concern over this ill-advised initiative. Thank you for giving me the opportunity to share these thoughts. I shall be glad to answer any questions Subcommittee Members may have.

Senator ROCKEFELLER. Thank you, Dr. Shill.

We unfortunately have only about 15 minutes before we are going to have five consecutive votes on five amendments to the INF Treaty, and I will go down and vote against every one of them, so I am not worried about that.

Incidentally, Commerce has now blocked OMB's proposal to privatize NTIS. I know that librarians continue to worry, however. I am aware of that.

Let me if I might ask you, Dr. Shill—and I will have a number of questions that I will not be able to ask this morning that I would have liked to. I was hoping we could go until noon, but the 11:30 thing now will cut us off.

It seems to me that—whatever a coherent national information policy is, we do not have one. Presumably other countries or some other countries do.

What is an example of a national information policy that is coherent, and what should we be doing?

Dr. SHILL. Well, I think probably the best example of one would be the one from Japan where they established the Japan Information Center of Science and Technology in 1955, and that organization has very assiduously collected, indexed, translated and disseminated foreign technical literatures to—

Senator ROCKEFELLER. Does that not operate out of the Prime Minister's office?

Dr. SHILL. I am not sure of the organizational arrangement.

Senator ROCKEFELLER. I believe it does, out of the Prime Minister's office, which would be interesting.

Dr. SHILL. It is, as I understand, a very sizeable operation and one which has had a major impact upon Japan's rapid advance and upon many of the other research advances we have been discussing earlier in the day. That is one which I would identify as a possible model.

We have a National Commission on Libraries and Information Science in this country which is given some responsibility for developing national policies. I testified before the House Committee on Science, Research and Technology last year and recommended them as a possible source for developing such a national policy, and Congressman George Brown who was on the panel at that time indicated to me that the NCLIS, as it is known, has had a lot of good ideas, but many of them have not been followed.

Most recently, the National Commission on Libraries and Information Science met with representatives of the British Library and also the National Research Council of Canada in Mississaugua, Ontario at a resort, I guess, which is called the Glenerin Inn, and they came up with something called the Glenerin Declaration on National Policy back in November. This statement basically stressed the free flow of information and also educating our citizenry to be information literate as well as technology literate.

So there is some movement in that direction. I am waiting to see whether that particular effort goes very far.

Am I answering your question?

Senator ROCKEFELLER. It is a huge question, and you are answering part of it.

Dr. Howard, if I might, sir, you are with Motorola.

Dr. HOWARD. I am on leave from Motorola at the moment.

Senator ROCKEFELLER. Yes.

You have helped organize some of this country's pioneering consortia for research, including the Semiconductor Research Corporation and the Microelectronics and Computer Corporation.

Well, obviously one question is do they work well, to your satisfaction? Do they help our country compensate for the fact that individual companies often lack the resources to invest in long term research? And should Congress encourage this Sematech style, or even assist Sematech style, consortia?

Dr. HOWARD. First of all, the report specifically mentions Sematech as the kind of activity that in appropriate circumstances should be encouraged. I watched, in the electronics industry, the attitude develop from a group of companies that competed fiercely in the marketplace, concentrated on beating each others brains out as much as possible, to coming together and joining in the face of a common foreign competitive threat, to begin to realize that consortia were necessary ingredients to achieving certain ends necessary for the industry as a whole.

And SRC was a primarily university-focused activity to support research and development within universities and to translate that into commercial products as quickly as possible.

In MCC, the participants got more closely allied together doing specific work for one another and with one another and has developed some significant technologies in its own right, and I believe it has contributed significantly to our company and to a number of others at well.

At Sematech we bring the Government into the picture, into a problem which is larger than any of the individual firms could reasonably be expected to address and yet is a matter of strong national interest.

There is a fundamental change in attitude that is going on. Companies that previously looked internally for their technology are beginning to realize that they must band together to develop some things that are bigger than they can develop individually. There is a lot more to go.

You asked whether these consortia are operating well. I would say that in many respects they are operating well, and in some respects there is a great deal more to be done. Particularly the issue on which the jury is still out is the effectiveness by which companies are able to transfer the technology developed in consortia to their own use. This generally involves keeping a mirror organization within the company, mirroring the consortium activity to be sure that you have somebody ready to catch the fly ball when it is batted from the consortium into your ballpark.

There also us a question of willingness on the part of companies to send their best people to a consortium where those best people would contribute not only to the company's well being, but also potentially to the well being of people you compete with vigorously in the market place.

These are major issues that are still being addressed, and in some cases the consortium issue is one which is still in my mind an experiment. It succeeded in some respects, and there are some respects where we just do not know.

I do sense, however, the competitive aspect of the business still is vigorous and still is important, but companies, particularly the senior officials in companies, are now willing to band together to do important things, and that to me is the important attitude change, one which is becoming accepted in many parts of the industry.

Senator ROCKEFELLER. Thank you.

There is a lot that is going international, and that includes technology. American owned plants simply moving overseas, and in some cases, taking their research labs with them and design groups. Now, we are an international world, and that cannot be stopped, perhaps should not be stopped, but nevertheless, research and design, process, whatever, being done offshore as opposed to in this country is not the description of national health.

Does this concern you, and how much of it do you think there is? What do you see as the trend?

Dr. HOWARD. It does concern me. We have studies under way within the academy complex of both the extent of internationalization of manufacturing and the internationalization of engineering to try to assess exactly what is going on.

It started in the late 1960s with the building of offshore manufacturing plants. As they developed, the engineering infrastructure to support them became internationalized. In an attempt to compete in the global market, we took a great deal of our product design skills and located them in the markets that they were to serve. In each case we have educated the local populations to the same level of skill that we have in our main U.S. operations.

That has interesting implications, and we are not sure exactly what those implications are. What it does mean is that we no longer have a monopoly on a large number of these critical technologies that we once enjoyed. Areas such as semiconductors that previously were virtually a U.S. monopoly are now virtually spread across the world, in Europe, in Asia. In Motorola we do a lot of our design in Israel because of the availability of technical people with certain skills that we cannot get readily here.

Some of the manufacturing skills that have developed in our offshore plants are not as available in the United States as they are in places like Korea and Singapore and Hong Kong and the Philippines. And as a result, we are tending to rely more and more upon offshore critical technology skills that we did not rely on before.

What this means, we do not know, and it is an open question but a serious one for us to worry about.

Senator ROCKEFELLER. In essence, your report calls for better cooperation between private industry and Government. More often than not, when businessmen come in, they want to talk about taxes, they want to talk about regulation, they want to talk about trade, they

want to talk about technical corrections in tax bills. They do not come in talking about National Science Foundation. They do not come in asking for Federal help on this or that. They specifically do not do that.

What is going to have to change to make your thoughtful and correct analysis mean something?

Dr. HOWARD. Well, first of all, the kind of attitude shift that is under way with the consortium issue also applies to relations with the Federal Government and with other entities, whether there are other companies, universities, other Governments.

The attitude has been traditionally that a company develops its own technology, regards that technology as an important aspect of its competitive strength, and it seeks to become the leader in the technology within itself. It is a thing that has developed since the 1920s and 1930s in our country. It is an important issue, though.

The development of that technology and the harboring of that technology is an important internal issue in many companies. The idea of going outside for technology is one which is a new one to many CEOs and a new one to many senior policy people. And the fundamental shifts in attitude that are required to make cooperation necessary are very slow in happening.

Perhaps it goes back to engineering education. Engineers are educated different from people in a liberal arts curriculum. Liberal arts major, when faced with a problem, goes to the library to find out what somebody else has thought about the problem. The engineer takes his problem set and goes home at night—in my day he got out his slide rule, now-a-days he gets out his computer or his calculator—works out the problems and the next morning he has invented himself the solutions to those problems

It develops an attitude that says you look inside first for your ideas, for your solutions to problems, and that is a reflection on many of the senior technical executives within companies. Sometimes it is called NIH, not invented here. Sometimes it is called a reluctance to display your competitive technical advantages to people who are potential competitors or who might leak the information.

But there is now beginning to be a realization that the company no longer is the focus for much of the technical activity. Things such as the superconductivity technology they came up with within the last 18 months were harbored within organizations like the Bureau of Standards and not in most U.S. corporations. Various other technologies in the materials areas may be more available outside the company than within.

And there is getting to be an increasing attitude, although slowly, that you have to begin to look outside as well as develop technology inside.

Senator ROCKEFELLER. One theory for industry's reluctance to do this kind of thing is that, let's say in comparison with Japan, about two-thirds of our chief executive officers are either lawyers, marketing specialists or public relations people, or accounting people. Whereas, in Japan, two-thirds are engineers, people trained in the sciences, and therefore production oriented, and therefore willing to take a much longer look.

I do not know if those statistics are precise. Do you see in American industry any increase in the weight being given to people who produce, who are trained in sciences, trained as engineers, who are interested in the final product, who are willing to look long term rather than short term? Is there something of an ethic developing on that in this country when promotion decisions are made?

Dr. HOWARD. Well, my own experience is primarily with one company where virtually all the senior officers are technically trained, either mathematicians, physicists or engineers. So perhaps my data base is not as comprehensive as it ought to be.

But in fact—

Senator ROCKEFELLER. Bob Galvin is a very farsighted fellow.

Dr. HOWARD. He is the one exception that is not technically trained, as a matter of fact. He turns out to be a classically trained liberal arts graduate, business graduate, but the interesting thing is I find that many of the nontechnically trained people are more willing to look outside the company for technical solutions than some of those who are technically trained.

I am not sure that—

Senator ROCKEFELLER. Explain that to me. That shoots my theory down.

Dr. HOWARD. Well, the idea of people being willing to find out what others have done is less new to people in that environment than people who are used to inventing their own solutions.

Senator ROCKEFELLER. All right, thank you.

Dr. Eyring, I am doing you a great disservice because we are only going to have about six minutes to talk. I have a lot of questions, as I also do with you, Dr. Hower, and some more for you, Dr. Shill, that I will write and ask you to respond as quickly as possible.

When most of us hear about advanced materials, we think of popular uses such as automobile engines, wings for aircraft or parts of wings for aircraft, that kind of thing.

Now, you have studied the field very closely. Where do you think in this country advanced materials are going to be most useful?

Dr. EYRING. If I could answer that in two parts, in the near term, most of the upcoming applications are going to be specialty in nature, and especially military in nature. In fact, we think that the military fraction of the markets for these materials will grow more rapidly in the near term than commercial markets, and that is a separate concern that I could address later.

In the long term, the really high volume applications, the applications in which you are going to use a lot of these materials, are pretty much the ones you mentioned, the automobile or aircraft. There are major opportunities on niche applications, particularly in medical devices. For example, I was just talking to a fellow in Tennessee the other day who was telling me that ceramic balls for hip joints in this country are really now being specified more and more by doctors.

There are some people who think that market segment could be as high as $1 billion by the year 2000. Others are more skeptical and put it at a much lower number.

But without question, in the long term, I think we are going to see these materials diffused down into applications, even perhaps into construction type applications, in advanced concretes, in bridge structures and so on.

Senator ROCKEFELLER. That is really interesting, is it not? That would be the idea of roads that simply do not get potholes. I mean, that is really quite exciting. West Virginia would be well pleased by such a thing.

How close is that?

Dr. EYRING. I do not think any technology promises to product roads with no potholes forever. But there are advanced concretes now being developed in the laboratories that have many times the strength and durability of current concretes.

The challenge there is twofold. One is that the costs are considerably higher, and so you have to amortize those costs over the expected lifetime of the project in order to have a successful application.

And secondly, the rate at which new technologies diffuse into particularly construction or infrastructure type applications is especially slow because the level of technical training of the people is not very high, the turnover is high, and it is an extremely fragmented industry.

So that is why those are classified as being relatively long term.

Senator ROCKEFELLER. I had better make this my final question, and I really do apologize to you because I have got lots of questions for you.

The Engineering Research Centers Program, NSF's program, is meant to be the model for universities and industry cooperation. Currently there are eleven such centers. There ought to be many more of them.

You have found, however, that while these collaborations offer important benefits to U.S. industrial competitiveness, they don't seem to promote or facilitate commercialization.

Why? What do you suggest?

Dr. EYRING. Well, by important benefits, I am talking about trained people and the opportunity to access smart professors and good graduate students. These are the benefits that industry typically cites for participating in the Engineering Research Centers, and from all I have been able to determine, they seem to be doing that very well.

Those are very important contributors to competitiveness, ultimately. You have to have the people in your company to do this kind of work. There is no substitute for that.

My point is simply that these centers do not see themselves when you interview the research managers and the industry participants do not see them as leading to a commercial product. Industry sees themselves as having that responsibility, and the managers express great frustration that they are not able to convince their CEOs that these technologies are sufficiently promising within the time horizons in which the firm has to—

Senator ROCKEFELLER. So then why does industry agree to cooperate in the first place? What is their original motivation for doing so?

Dr. EYRING. As I said, they are interested in the access to the people because they want to position themselves potentially for the future, and also as a window on the future and what is happening at the best universities.

Senator ROCKEFELLER. All right.

I thank all three of you. Again, I apologize. I will have questions. I hope you will respond.

You have greatly contributed to our state of knowledge, and I appreciate your presence.

This hearing is adjourned.

[Whereupon, at 11:40 p.m., the committee recessed subject to the call of the Chair.]

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

STATEMENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS ON BEHALF OF THE AMERICAN ASSOCIATION OF ENGINEERING SOCIETIES, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, AND THE SOCIETY OF FIRE PROTECTION ENGINEERS

EXECUTIVE SUMMARY FISCAL 1989 FUNDING FOR THE CENTER FOR BUILDING TECHNOLOGY AND THE CENTER FOR FIRE RESEARCH

The American Society of Civil Engineers (ASCE), on behalf of the American Association of Engineering Societies (AAES), the National Society of Professional Engineers (NSPE), and the Society of Fire Protection Engineers (SFPE), respectfully urge the committee to reject the Administration's proposed fiscal 1989 budget cuts for the Building Technology and Fire Research Centers (CBT and CFR) in the National Bureau of Standards.

The Administration's fiscal 1989 budget request would merge CBT and CFR at a combined funding level of only $5 million, 45% below the fiscal ?988 level of $9 million. Fiscal 1989 funding for CBT and CFR should be sustained at the fiscal 1988 levels of $3.5 million and $5.5 million, respectively. It is important to realize, however, that a continuation of CBT and CFR funding at current levels will not ameliorate the severe budgetary erosion that has occurred over the last 8 years. Since 1980, for example, CBT programs and staff have declined by approximately 50%. CBT funding, in current dollars, is less today than it was in 1980. Current CFR funding is less than one-third the level envisioned as essential by the National Commission on Fire Prevention and Control in 1974.

The rationale for merging and cutting these research programs is that their activities will be undertaken by the private sector and state and local governments. Numerous organizations and Congress have rejected this position previously because of the unique services performed by CBT and CFR. Furthermore, the nation's commitment to improving U.S. economic competitiveness and technological development underscores the importance of CBT and CFR. NBS building and fire research improves the usefulness, safety, and economy of buildings and enhances the international competitiveness of U.S. construction services and products. The American Society of Civil Engineers (ASCE) on behalf of the American Association of Engineering Societies (AAES), the National Society of Professional Engineers (NSPE), and the Society of Fire Protection Engineers (SFPE), representing over one half-million engineers, appreciates the opportunity to present testimony on the Administration's fiscal 1989 budget request for the Building Technology and Fire Research Centers of the National Bureau of Standards (NBS).

The Administration's fiscal year 1989 budget proposal calls for merging the Center for Building Technology (CBT) and the Center for Fire Research (CFR) and drastically cutting available funds for these unique and important programs. The Administration proposes to reduce NBS building research and fire research to $5 million base funding in fiscal 1989, down 45% from 9 million in fiscal 1988.

Just two years ago, Congress agreed to reduce funding for CBT and CFR at the level of $9 million in fiscal 1987, in return for the Administration's agreement not to propose further funding cuts for building and fire research. The Administration's fiscal 1988 request to merge CBT and CFR at a reduced funding level of $5 million, appeared to abrogate this budget accord, and was properly rejected by Congress. The Administration's fiscal 1989 request is a repeat: of last year's proposal and it should once again be opposed by this committee.

As in previous fiscal years, when the Administration proposed outright termination of CBT and CFR, the rationalization for merging and cutting these research programs is that the resulting void will be filled by the private sector or state and local government. This rationalization, which this committee and the Congress have rejected in recent years, belies the numerous statements filed on behalf of a variety of organizations that stressed the valuable role performed by the Centers for Building Technology and Fire Research. The continued budget assault on CBT and CFR is, indeed, perplexing if not alarming, particularly in light of the Administration's expressed commitment to improving U.S. economic competitiveness and technological development and excellence. Foreign competitors continue to strengthen their position in the construction industry through increasing research and development. NBS building and fire research improves the usefulness, safety and economy of buildings and enhances the international competitiveness of U.S. construction services and products.

ASCE, AAES, NSPE, and SFPE support, without equivocation, full funding for CBT and CFR at the fiscal 1988 level of $9 million. The specialized laboratory facilities and expert professional staffs of the Center for Building Technology and Center for Fire Research are essential public resources that should be preserved, and not destroyed.

CENTER FOR BUILDING TECHNOLOGY

The Center for Building Technology is the national building research laboratory. It performs field, laboratory and analytical research to develop measurement techniques and to evaluate the performance of construction materials, components, and systems. The performance prediction and measurement technologies produced by CBT are relied upon by private industry and all levels of government to provide technical bases for responsible and cost-effective construction decisions. The program includes substantial efforts in quality assurance and condition assessment, advanced computation and automation, structural engineering, earthquake hazard reduction, building physics, materials and equipment.

CBT is the only research program that integrates complex technical issues affecting the vast building industry. Despite the fact that it amounts to about 9% of the GNP, and that almost two-thirds of the nation's wealth is invested in constructed facilities, the huge building industry is quite disaggregated.Because of the industry's size and diversity, it is difficult to imagine any institution in the private sector or at the state level duplicating CBT's efforts or adequately distributing the findings on its own. This interdisciplinary laboratory also integrates complex technical issues in a way that more narrowly-focused proprietary research and development cannot.

Some of the unique and valuable aspects of the CBT are:

Unique and comprehensive facilities such as a tri-directional structural test laboratory, 12-million pound testing machine, environmental chambers, guarded-hot-plate and calibrate hot-box, plumbing tower, anechoic and reverberation chambers;

An integrated, nonproprietary program for removing technological market barriers to the construction industry as well reducing unnecessary or ineffective building regulations without compromising essential levels of safety. This is the major technical information source for the development of voluntary standards by groups such as ASCE;

A quality assurance program for 1000 public and private laboratories used by designers, owners, builders and state and local governments responsible for building and transportation.

CBT also provides the authoritative laboratory support for federal agencies that need assistance in developing criteria for the design, construction and maintenance of their facilities. Although we cannot offer solid statistical evidence, the technical support from the CBT provides the federal government with significant savings in the lifecycle costs in the operation and maintenance of its buildings.

The following case illustrates the vital role CBT provides to the building industry. On January 1, 1985, the management responsibility for the ANSI (American National Standards Institute) A58-1984 Standard, "Minimum Design Loads for Buildings and Other Structures," was transferred from CBT to ASCE. This standard is the only nationally recognized voluntary consensus on structural loads in the United States. It is widely used as a resource document by other codes and standards groups, regulatory authorities and engineers confronted with unusual design situations not covered by building codes.

Though management of the Standard will now reside with ASCE, and thereby with the private sector, CBT will continue to be the principal source of new technology to update ANSI A58. CBT programs such as Wind Loads on Buildings, Seismic DesignCriteria, Floor Loads, Fire Loads, Reliability Analysis and Design Analysis have been and will continue to provide invaluable input for the standard. Without future technological support by CBT programs, the future of this important standard will be seriously compromised.

During the past decade, inflation and budget cuts have significantly reduced support for NBS building research. Moreover, Federal agencies with building-related programs have curtailed funding for research. NBS has also received new responsibilities such as earthquake hazards reduction and structural failures investigations, but without the benefit of additional resources. Despite budget difficulties, CBT has commenced research in areas critical to U.S. competitiveness in construction, including advanced computation and automation in building design, construction and use; automatic controls on building service systems; and indoor air quality. Unfortunately, research has been eliminated in other areas including foundations and geotechnical engineering.

CBT's recent accomplishments are many, they include: the first full-scale laboratory test in the U.S. of a bridge column subjected to a simulated earthquake; the 1985 Mexico earthquake investigation; an independent analysis of the new U.S. Embassy Office building under construction in Moscow; and investigation of the L'Ambiance Plaza collapse in Bridgeport, CT. Maintaining the technical quality of the U.S. construction industry is vital to the quality of life, public safety, and U.S. economic competitiveness. The U.S. can ill afford to lose domestic and international markets for U.S. construction services and products to foreign competitors with strong R&D bases. As the principal source of non-proprietary R&D for the construction industry, it is imperative that we sustain the NBS building research program.

CENTER FOR FIRE RESEARCH

The Center for Fire Research also contributes to public safety in a way that no privately-funded research effort could. CFR explores the processes that initiate, propagate and suppress real fires. As a result, realistic material test methods of fire control and extinguishment can be developed. Like CBT, CFR does not promulgate or enforce standards or regulations. Instead, it provides technical support to voluntary standards and model codes groups, engineers, the building industry and fire organizations.

CFR is the world leader in the development of mathematical fire models and computer simulation. Given the disturbingly high fire death rate in the U.S., the importance of CFR programs cannot be overemphasized. Despite an improved U.S. fire loss record over the last decade, each year U.S. fires result in over 6,000 deaths, 200,000 injuries, and $7.5 billion in property losses.

The proposed reduction for CFR from $5.5 million in fiscal 1988 to $2.75 million in fiscal 1989, would seriously impair a number of salient CFR activities and call into question the future viability of the organization. The proposed budget cuts would:

1. Essentially eliminate the already reduced NBS presence from U.S. and international fire safety standards and code activities seriously compromising the basis for consensus in these areas.
2. Further restrict the already limited technology transfer activities of CFR for bringing the results of fire research into practical application. Numerous groups including the National Academy of Sciences have pointed to the need for expansion of CFR efforts in this area.
3. Eliminate CFR's limited capacity to respond to disastrous fires such as the Dupont Plaza Hotel fire, resulting in the loss of potential public benefit from scientific evaluation of causal and possible remedial factors.
4. Place current CFR efforts to deliver a viable and technically valid method for toxic potency measurement in jeopardy.
5. Lead to abandonment, or at least mothballing, of CFR's effort to deliver practical fire hazard assessment methods, a crippling of the industry-funded National Fire Protection Research Foundation Risk project which builds on this work, and a certain loss to the U.S. of potential world leadership in development and marketing of fire hazard and risk prediction tools.

6. Leave the U.S. with virtually no investment in next generation fire protection technology development, at a time when the potential for quantum improvements in these technologies are within our vision. This effort is already subcritical.

7. Force reduction of the fire research grants program by 5?% leaving no academic centers of excellence in fire research in the U.S. at a time when our international competitors are building up such capabilities, and virtually halt the flow of fire researchers and protection engineers into the economy.

Current CFR funding of $5.5 million is less one third the level called for by the National Commission on Fire Prevention and Control in 1974. Consequently, a number of CFR activities have already suffered including work on the Toxicity Performance Test Method, Fire Investigations, Fire Initiation Model, National Fire Database, Fire Safety Education, Fire Hazard and Risk Assessment, Advanced Suppression and Detection Technologies, and Technology Transfer. CFR's leadership role in fire codes and technology for fire standards has also been undermined.

If the specter of eliminating lifesaving opportunities does not deter efforts to curtail the CFR, the cost-saving implications should persuade a budget-conscious government to reconsider the proposal. Fire-safe building design techniques can save money for all sectors of our society. Through use and implementation of scientifically-based models and evaluation tools, CFR is attempting, by the end of the century, to reduce fire deaths by 3,000 per year and fire protection costs by $15 billion per year. Mr. Chairman, the budget request for CFR is at best, harmful to the economic interests of the American people, and at worst, life-threatening.

The ASCE, AAES, NSPE, and SFPE commend efforts to reduce the federal deficit, but we must also warn against the myopic reduction of essential programs that will not be duplicated fully by the private sector.

The services provided by the Centers for Building Technology and Fire Research are invaluable to an important sector of our economy, the building industry. We urge Congress to preserve these vital programs.

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